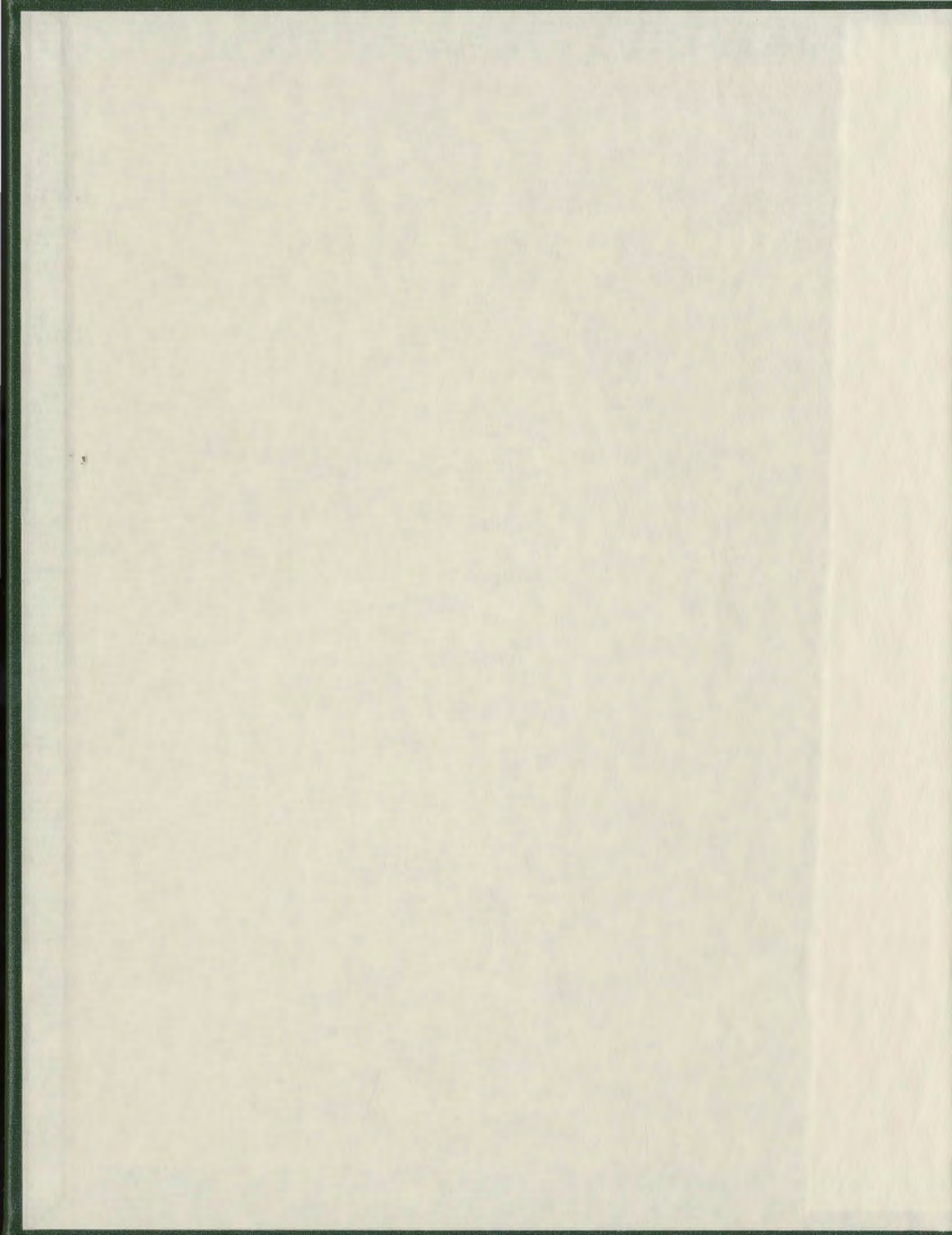


EDUCATIONAL LEADERS' PERSPECTIVES OF
HIGH SCHOOL SCIENCE EDUCATION IN
NEWFOUNDLAND AND LABRADOR

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**EDUCATIONAL LEADERS' PERSPECTIVES OF
HIGH SCHOOL SCIENCE EDUCATION
IN NEWFOUNDLAND AND LABRADOR**

By

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**A thesis submitted to the School of Graduate Studies
in partial fulfillment of the requirements
for the degree of Master of Education**

**Faculty of Education
Memorial University of Newfoundland
August 2009**

St. John's

Newfoundland and Labrador

DEDICATION

This work is dedicated in loving memory of

my grandparents,

**Felix Power, Agnes (Nan) Walsh, and John (Jack) Walsh,
who taught me the importance of hard work and sacrifice**

and

my life long babysitter,

Lucy Browne,

the woman who knew what life is all about.

ABSTRACT

This qualitative study examined the perspectives of educational leaders in Newfoundland and Labrador regarding high school science education. A questionnaire was emailed to 20 participants including principals, vice principals, science department heads, lead teachers and directors from across the province. Participants responded to questions regarding scientific literacy, issues in science education and the link between science education and the workforce.

Responses were subjected to qualitative analysis and yielded a number of emergent themes and predominant categories. The study was driven by the following general research question: What are the perspectives of educational leaders regarding high school science education in Newfoundland and Labrador? The subsidiary research questions were as follows:

1. How do principals, science department heads, and lead teachers view science education?
2. What does scientific literacy mean to educational leaders in Newfoundland and Labrador?
3. What are the major issues facing science educators in Newfoundland and Labrador?
4. What are the roles of principals, science department heads and lead teachers in the delivery of science education?
5. What are some innovative methods that are used to improve the delivery of science education and to promote scientific literacy in Newfoundland and Labrador?
6. How can the delivery of science education be improved to better meet the changing needs of our workforce?

The study found that educational leaders perceive that science education is important in helping students develop the skills necessary to be contributing members of society. The study's findings included a discussion of the definition of scientific literacy the issues faced by science educators in Newfoundland and Labrador as well as suggestions on how to improve the delivery of science education. Two major findings of the study were that the role of educational leaders in the delivery of science education is not well defined and that rural schools face unique challenges in the delivery of science courses.

ACKNOWLEDGEMENTS

A number of people have supported me during my Master's studies and I would like to express my sincere appreciation to them. Thank you to my supervisor and friend, Dr. Jerome Delaney for the weekly meetings and invaluable advice. You not only helped me choose a very rewarding path of studies, but also kept me sane in the process with your words of encouragement and helpful anecdotes.

I would also like to acknowledge the support of the four school districts who granted me permission to conduct this study, the Eastern, Labrador, Nova Central and Western School Districts.

A special word of thanks to Shawn, Marg and Steve Craig. Shawn and Marg, thank you for welcoming me into your home and giving me a place to work and live. And to Steve, who has supported my busy schedule, put up with my craziness, encouraged me to keep going when I thought I could not continue, and helped me learn how to relax. I appreciate everything you do for me and I love you.

And to those people who have stood by me throughout my life – my family. Thank you mom and dad for always believing in me, for supporting and encouraging me in everything I do. I am where I am today because of you two. I love you and admire you both. Thank you to my brother, Jonathan, for keeping my feet on the ground and to my sister, Heather, for always looking after me. I couldn't ask for two better siblings. Our family has a strong bond, and although no one will ever quite understand our supper time conversations, I love you all unconditionally!

Finally, a huge thank you to the principals, vice principals, department heads, lead teachers, and directors who volunteered to take part in my study. Without your support, this thesis truly would have not been possible.

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CHAPTER 1

Introduction to the Study

Science education is a key element in enhancing a country's competitiveness in the global marketplace. Cogburn (1998) contends that a robust and high capacity "Global Information Infrastructure" is needed to facilitate global restructuring and to meet the needs of global citizens. He discusses the impact of globalization on knowledge, education and learning and suggests elements of educational reform in response to globalization that need to be included or enhanced in our present education system. Several of these elements specifically deal with reforming science education, for example

- focusing on abstract concepts;
- enhancing students ability to manipulate symbols, acquire and utilize knowledge;
- producing more scientifically and technically trained persons;
- blurring the distinction between mental and physical labour; and
- breaking the boundaries of space and time.

Although our economy is changing rapidly in response to technological advances in society, our school systems have "failed to respond quickly and effectively" (Hodson, 2008, p. 103). In order to secure a prominent position in the global marketplace, society needs to invest in science education and ensure scientific literacy for all citizens regardless of race, gender, socioeconomic status, or geography.

Hodson (2008) contends that a major problem in science education is restricted access and indeed if scientific literacy is imperative in creating global citizens then it should be accessible by all. Industrialized countries are adapting to changes in technology whereas developing countries are struggling since the modern infrastructure is

not in place to facilitate change (Cogburn, 1998). The key element in keeping abreast of the competitive global economy, according to Cogburn, is to invest in research and development. He states that the "education and learning paradigm ... is under increasing pressure to better meeting the demands of this new knowledge and information-intensive global economy" (p. 3). If we take Cogburn's advice, then we must research current issues in science education to determine if our curriculum is creating scientifically literate students who are prepared to meet the demands of the modern workforce. Are we preparing our students to become global citizens?

For many years science curricula have focused on learning conceptual and theoretical knowledge about science. In order for students to become excited about science and want to continue with the subject they need to "do" science themselves, that is, carry out experiments, ask questions, critically think about a problem, and explore an issue that interests them. Curricula are heavy laden with knowledge-based outcomes and there is sadly room for educators to nurture the science spirit in students.

1.1 Purpose of the Study

The main purpose of the study was to survey principals, science department heads and lead teachers in Newfoundland and Labrador in order to examine the current issues facing high school science educators in Newfoundland and Labrador and the methods used to increase scientific literacy. The study was designed to determine whether or not these educational leaders perceive science education to be important when preparing students for the future.

1.2 Statement of the Problem

Much of the literature that deals with science education is specific to a certain discipline, for example exploring motivation and performance in the Physics classroom (Berger & Hanze, 2009), using models to teach chemical equilibrium (Flavia & Justi,

2009) or exploring the ethics of genetic testing (Markowitz, DuPre, Holt, Chen, & Wischnowski, 2006). If we are to prepare students for the competitive global marketplace then we must look to educational leaders in science education, those individuals who work closely with teachers and students but who can also influence the changes needed to keep our education system competitive. There is an obvious connection between educational leadership and change in science education; yet there is a lack of research available on this topic. This study examines the perspectives of principals, science department heads and lead teachers to learn about their roles in the delivery of high school science education and how they believe we can better prepare students for the world of work.

1.3 Research Questions

The study was guided by a general research question and several subsidiary research questions. The general research question is: What are the perspectives of educational leaders regarding high school science education in Newfoundland and Labrador? The subsidiary research questions are:

1. How do principals, science department heads, and lead teachers view science education?
2. What does scientific literacy mean to educational leaders in Newfoundland and Labrador?
3. What are the major issues facing science educators in Newfoundland and Labrador?
4. What are the roles of principals, science department heads and lead teachers in the delivery of science education?

5. What are some innovative methods that are used to improve the delivery of science education and to promote scientific literacy in Newfoundland and Labrador?
6. How can the delivery of science education be improved to better meet the changing needs of our workforce?

1.4 Significance of the Study for Research and Practice

The general public is often intimidated by complex scientific processes that they do not understand. People will indeed have a greater comfort level with science if they can relate it to something familiar in their everyday lives. As Zeman (2005) argues, science education is crucial because it is through the application of science that we are able to invent the modern technologies that we use from day to day. What we must be cognizant of, however, is how the delivery of science education is often determined and distorted by “scientists, journalists, politicians, religious leaders, and so on” (p. 43). The information that is chosen to make up our curriculum and how this information is translated within the classroom is influenced by many factors.

Curriculum content will determine a student’s exposure to scientific concepts and Hodson (2008) comments that politics greatly influences curriculum. What material is covered, how concepts are taught and assessed and which subjects are offered are all affected by those individuals who are charged with developing curriculum and creating educational standards. Although teachers are working with students daily, they have little impact on what content is covered. Teachers can choose to supplement topics and provide enrichment, but they still have to cover what is prescribed by the Department of Education. How then do we go about improving science education?

There is indeed an abundance of literature on the topic of science education (a search of ERIC gives 56604 articles), but when we narrow our focus specifically on

improving science education in high school there seems to be a gap in the research. Specific programs and techniques are offered to help classroom teachers improve teaching and learning, but the research does not indicate how to influence science education at the leadership level. Specifically how do educational leaders influence science education at the classroom level and how do they perceive this role? This study was designed to explore the perspectives of educational leaders regarding high school science education since it is these individuals who can help to improve the delivery of science education. If we want to create a scientifically literate population who is going to lead the way in technological advances, we need to look to the leadership positions in our schools, principals and department heads where change can begin. Educators in leadership positions can help to improve the curriculum in science education in a variety of ways. Science department heads and lead teachers can advocate for changes in science by communicating with principals, and principals can then communicate these needs at the district level at principals meetings or through special correspondence. Educational leaders in general can also provide input through committee work at the Department of Education or by doing graduate research focusing on science issues. Such avenues are not as accessible to the classroom teacher.

1.5 Terminology

For the purpose of this study the following definitions were used:

- Lead teachers: teachers who assume leadership positions in schools that do not have the population to allocate department head status as defined by the provincial government. These teachers perform the same duties as department heads but do not receive the financial bonus.
- Technologies: devices or approaches that can be used in science education to help increase and develop scientific literacy.

1.6 Delimitations

Delimitations are used to “address how the study will be narrowed in scope” (Creswell, 1994, p. 110). This study included the following delimitations:

1. only principals, science department heads and lead teachers in Newfoundland and Labrador willing to participate in the study were interviewed; and
2. the study examined only the perspectives of these individuals regarding science education in Newfoundland and Labrador.

1.7 Limitations

Limitations “identify potential weaknesses of the study” (Creswell, 1994, p. 110). The limitations of this study included:

1. the substantial reliance of the study upon the perspectives of participants as articulated in the questionnaire;
2. the study used only one approach to gather data; and
3. the skill and knowledge of the researchers in developing the questionnaire and analyzing the questionnaire data.

1.8 Assumptions

The following assumptions were made when conducting this study:

1. that participants, based on their work in the school system in Newfoundland and Labrador, had developed perspectives regarding the delivery of high school science education; and
2. that the participants were truthful when responding to the items on the questionnaire and were willing to share their perspectives with the researcher.

1.9 Organization of the Thesis

This thesis contains six chapters. Chapter 1 gives an introduction to the study by presenting both the purpose of the study and stating its significance for research and

practice. The general and subsidiary research questions are presented along with the definitions, delimitations, limitations and assumptions that guide the research. Chapter 2 presents a review of the literature, starting with the definition of scientific literacy and stating the significance of science education for future employment. The delivery of science education in Newfoundland and Labrador is also discussed focusing on the role of educators and technologies that are used in the science classroom. In Chapter 3 the researcher discusses the research design and methods used to analyze the questionnaire data. This chapter concludes with a discussion of trustworthiness and ethical issues surrounding the study. Chapter 4 presents the analysis and interpretation of the data. Each item on the questionnaire was analyzed individually and the emergent themes from each question are presented in this chapter. Chapter 5 discusses the findings of the study with reference to the specific research questions above. The final chapter presents a number of conclusions resulting from the study and discusses a number of implications that are significant for research and practice in education.

CHAPTER 2

Review of the Literature

2.1 Scientific Literacy

Scholars agree that in order for people to participate in debates regarding science, technology, society and the environment they must be scientifically literate (Blades, 2003). But what does scientific literacy mean? According to Bybee (1997) James Bryant Conant was the first person to use the term in 1952 although it was Paul DeHart Hurd who used scientific literacy as a theme for science education. Hurd (1958) emphasized the link between science and society stating that "human welfare and social progress are in some manner influenced by scientific and technological innovations" (p. 15). Since its conception several educators have presented their own interpretations and understanding of scientific literacy. In a review of the literature, Pella, O'Hern and Gale (1966) proposed that being scientifically literate means understanding the relationships between science and society, understanding the methods of science, having knowledge of science concepts, being able to distinguish between science and technology, and being able to link science as part of the humanities. Surprisingly, not a lot has changed with this definition in over forty years. Several authors have added new stipulations to what constitutes scientific literacy, but for the most part the findings of Pella et al. back in 1966 are still relevant to us today.

Perhaps one of the most significant pieces of literature relevant to this study is an interpretive review presented by Kemp (2000) regarding the goal of scientific literacy for all. Kemp identifies the elements of scientific literacy as presented in the literature from 1958-1998. Up to 1963, 10 key elements were identified including intellectual independence, science communication, science and society, conceptual knowledge,

science and technology, science in everyday life, the ethics, nature and history of science, and science appreciation. In the almost twenty years to follow the only additional element that was added was “Science in the humanities”, which refers to “the relation of science to other disciplines in the curriculum, and the mutual influences that ... (they) might have had on one another” (p. 35). In 1996, the National Research Council published the *National Science Education Standards* (NRC, 1996), commonly referred to in the literature as the Standards, with the goal of increasing scientific literacy in the United States. The Standards provide a quite lengthy definition of scientific literacy, incorporating all 10 key elements as identified by Kemp in the literature up to 1963. Although Science in the humanities is omitted, the Standards reveal two new elements of scientific literacy – “Science skills” and “Science and mathematics” (Kemp, 2000, p. 36). Science skills includes not only having content knowledge but also being able to perform scientific tasks, whereas Science and Mathematics explicitly refers to the connection between these two disciplines in relation to scientific literacy. Several authors have presented their own interpretations, views and perceptions of what scientific literacy means, such as Koelsche and Morgan (1964), Agin (1975), Gabel (1977), Arons (1983), Miller (1983), Shamos (1995), Bybee (1997), Hurd (1998), and Roth and Baron (2004). Although several common elements continue to arise, it appears that no two publications are consistent with an accepted definition of scientific literacy. In more recent times it seems that people are not as concerned with defining scientific literacy; rather, they are concerned with the impact that scientific literacy will have on the future of our young people, and the future of our world.

Bybee (1997) states that scientific literacy can be used as a slogan for contemporary educational reform or as a metaphor for “the goals and purposes of science education” where being scientifically literate means “being well\educated and well-

informed in science” (p. 71). More specifically, Cavanagh (2008) defines scientific literacy as “the ability to understand science, its role in society, and to make informed decisions as citizens, based on scientific evidence and knowledge” (p. 12). Hodson (2008) adds that a scientifically literate individual can read and understand science articles, make informed decisions about problems in the world and at the same time have the “capacity and willingness to act in environmentally responsible and socially just ways” (p. 103). This individual not only has the knowledge and skills needed to retrieve necessary scientific information as suggested by Murphy, Beggs, Hickey, O’Meara and Sweeney (2001), but also has the aptitude to make decisions considering the impact on humanity. The definition of scientific literacy is shifting away from the pursuit of technology and towards a view of the earth as a system of interacting components (Meyer, 2002). Authors appear to be more concerned with the state of our planet and how scientific literacy can be used to train students to make decisions to ensure sustainability.

Science curriculum in Canada has undergone significant changes in recent years in response to the need for scientifically literate students. In the past, science curriculum focused on preparing a limited number of students for post secondary programs specifically related to science and engineering (Roscoe & Mrazek, 2005). The demands on science curriculum have changed as result of “a rapidly changing society, a growing knowledge base in science and technology, an increase in science-related social and environmental problems, and an integrated global economy” (p. 12). Science education not only includes the goal of teaching academics but also includes personal and social goals. According to Roscoe and Mrazek (2005) scientific literacy in Canada delineates what all “citizens need to know and be able to do to live fulfilling and responsible lives, contribute to the nation’s economy, and participate fully in a democratic society as

informed decision-makers” (p. 13). Scientific literacy is no longer isolated to science related issues. As members of one global community we need to instill a mindset in our young people to ensure that future generations will enjoy prosperity and wellbeing. We cannot continue to exploit the earth for our own personal gains and feel no remorse for the destruction that mankind continues to inflict on Mother Nature. Responsibility is a word that continues to arise in the literature on scientific literacy; although a main goal of education is to secure meaningful employment in the future, the decisions made along the way must be responsible ones that do not jeopardize the sustainability of future generations.

2.2 Globalization and Employment Opportunities

Science education is not all about facts and figures, lab work and memorizing procedures. Science affects our everyday lives and indeed science education touches on issues regarding global citizenship and democracy. People in general agree that science education can improve a nation’s economy and that improving science education will enhance “a country’s competitiveness in the so-called global economy” (Hodson, 2008, p. 103). By reformulating science education, talented, intelligent and well trained individuals will choose careers related to science which will in turn revitalize the economy. Students need to develop critical thinking skills in the science classroom and then apply these skills to decision-making in their lives. Students will become the leaders in our communities, provinces, and countries. Educators need to equip students with critical thinking skills and challenge their values and beliefs so that they can embody the sustainable practices that will ensure the survival of our society. Students who leave high school and cannot critically analyze data are unprepared for problem-solving in the real world.

Globalization is impacting the development and delivery of science education. Carter (2008) defines globalization as “the recent transformations of capital, labor, markets, communications, scientific and technological innovations, and ideas stretching out across the globe” (p. 617). How science is taught and, perhaps more importantly what aspects of science are taught is largely influenced by the demands of the global marketplace. Is the purpose of our science curriculum to prepare students for a vocation? Many educators would agree that the main purpose of school is to prepare students for the world of work although Carter sees “vocational preparations as less important” (p. 628). Carter sees the main purpose of science education is to “help students understand and make critical judgments about science in ways that can enhance their engagement to work for a more socially just, equitable, and ecologically sustainable world” (p. 628). She suggests that a Problem Based Learning (PBL) approach is better akin to “globalism’s science” where real world examples are used and viable solutions are developed by students and teachers act as facilitators in this process. It is perhaps too early to determine the full impact that globalism has had on science education, but we cannot ignore the fact that science education is influenced by economic interests. Employers want to hire people that bring a particular skill set to the workplace. Individuals responsible for the development of science curriculum need to ensure that the proper skills are taught so that students will have equal opportunities in the ever-changing job market.

Coles (1998) conducted a survey to determine the qualifications required of employers in science organizations and tutors in higher education science courses in England, Wales and Northern Ireland. Several general skills are identified as essential by both groups including comprehension, health and safety awareness, human impact on the environment, information handing, information technology skills, problem solving and

teamwork. Although tutors in higher education require more skills in algebra, chemistry and physics, employers require additional practical techniques. Both groups agreed, however, that students who could perform basic tasks well are a better asset than those who study a wide range of topics or specialize in a particular topic. High school science curriculum has traditionally focused on the acquisition of a broad knowledge base in science from core areas of biology, chemistry and physics and has therefore neglected to ensure students can perform basic science tasks well. It appears educational institutions are more concerned with large quantities of content (as is evident from science curriculum guides) as compared with preparing students for the world of work. Science exams test content whereas the “practical capability and *application* of ideas” should dominate the recall of knowledge (p. 619). The high school science program can act as a “closed system” recycling “an established view of science which is centered on propositional knowledge rather than routes to such knowledge” (p. 619). School science should mirror what is practiced in industry and research in order to prepare students for the many technical jobs that exist today. Businesses around the world have changed the way they operate in response to globalization and students need to be educated and aware of how businesses operate in order to smoothly enter the competitive job market.

Countries have realized the economic benefits of having a scientifically literate population and as a result have raised demands on achievement, created national standards, become more accountable and started to focus on results of international testing (Jenkins, 2003). Such movements nationally can only come to fruition if educators are changing science education locally. To prepare students for the global marketplace, Hodson (2008) suggests that education must focus on current and relevant issues so that students can move through the following levels of sophistication:

Level 1: Appreciating the societal impact of scientific and technological change, and recognizing that science and technology are, to some extent, culturally determined.

Level 2: Recognizing that decisions about scientific and technological development are taken in pursuit of particular interests, and that benefits accruing to some may be at the expense of others. Recognizing that scientific and technological development is inextricably linked with the distribution of wealth and power.

Level 3: Developing one's own views and establishing one's own underlying value positions.

Level 4: Preparing for and taking action. (p. 104)

In order to realize this progression and subsequently develop scientific literacy we must take into consideration how science curriculum is developed and delivered.

2.3 Science Education in Newfoundland and Labrador

In 1995, the Council of Ministers of Education, Canada (CMEC, 1995) released the Pan-Canadian Protocol for Collaboration on School Curriculum. This document is a set of guidelines and objectives that outlines the need for a more streamlined approach to education in Canada. The goal of the CMEC at that time was to facilitate collaboration among provinces and territories through sharing resources to ascertain a quality, equitable and effective delivery of education to all Canadian citizens. In 1997 the CMEC initiated a *Common Framework of Science Learning Outcomes K-12*, a curriculum development project that contains foundation statements revealing scientific literacy as the vision for education in Canada. Since that time the following goals have been widely accepted across Canada to promote scientific literacy (Roscoe & Mrazek, 2005):

Students will: develop a sense of wonder and curiosity about science and technology; use science and technology to acquire new knowledge and solve problems; critically address science-related societal and environmental issues; develop a foundation in science that prepares them for higher levels of study and science-related occupations; and develop a knowledge of careers related to science, technology, and the environment (p. 12).

To follow suit, the Atlantic Canadian Provinces adopted the common approach outlined by the Pan-Canadian Framework and released *Foundations for the Atlantic Canada*

Science Curriculum in 1997. The purpose of this document is multidimensional and includes such aims as identifying the knowledge, skills and attitudes necessary to nurture scientific literacy; presenting the current view of the nature of science; and describing an instructional environment where effective learning occurs (Atlantic Provinces, 1997). The Atlantic Provinces have thus adopted scientific literacy as their vision for science education:

... science curriculum is guided by the vision that all students, regardless of gender or cultural background, will have an opportunity to develop scientific literacy. Scientific literacy is an evolving combination of science-related attitudes, skills, and knowledge that students need to develop inquiry, problem-solving, and decision making abilities, to become lifelong learners, and to maintain a sense of wonder about the world around them. (p. v)

This definition emphasizes that science education is for all students regardless of their background, but also regardless of their future path. Science education is not solely based on training scientists, but rather creating citizens that will continuously develop science related skills. Scientific literacy, therefore, is not something that is achieved; it is a concept or goal that we will constantly strive to meet. As our world continues to change at an alarming rate, we need to ensure that our students can adapt whilst continuously creating new and improved approaches to science education. Science teachers, department heads and principals are all science leaders at the school level who have major roles to play in the delivery of science education.

2.4 Role of Educators

The National Science Teachers' Association (NSTA) outline a series of declarations that delineate the responsibilities of science leaders in the areas of teaching and learning, professional development, curriculum, and assessment (NSTA, 2003). According to NSTA, science leaders are a network of individuals committed to and involved in science education, including such people as principals, lead teachers, science

department heads, and community leaders. The list of declarations made by NSTA has been adapted to reflect the roles of educators pertinent to this study (see Table 2.1).

Table 2.1: The Roles of Science Leaders (adapted from NSTA, 2003).

Science teachers must:

- Ensure that scientific inquiry and process skills are elements of instruction
- “Encourage the use of student self-assessment in the classroom”
- Communicate progress to students and parents
- Align assessment and instruction with provincial standards
- Align assessment methods with specific curriculum outcomes
- Use a variety of assessment techniques

In addition to the responsibilities stated above for science teachers, science department heads must also:

- “Encourage the use of a variety of teaching styles” (including differentiated instruction and cooperative learning)
- Facilitate regular science department meetings “designed to improve science instruction”
- Promote collaboration within the department
- Provide mentoring support for science teachers
- Promote the use of assessment data to inform instruction

In addition to the responsibilities stated above for science department heads, Principals must also:

- Facilitate regular meetings with department heads and the entire teaching staff to improve teaching and learning
- Actively involve teachers and department heads in decisions regarding “professional development programs, curriculum changes, and other activities that affect their practice”
- Promote collaboration and partnerships among teachers, school board officials, the Department of Education, and other groups who are committed to the improvement of science education
- Provide a mentor for new teachers
- “Provide support for the development and use of assessments that addresses the needs of diverse learners” and develops scientific literacy
- “Promote teacher use of assessment data to inform instructional practice”

Regardless of policy documents and curriculum reform efforts, it is the people at the grassroots level who initiate and create change in the classroom. Departments of education pass regulations on to school districts, who in turn relay the information to principals who are responsible to initiate the change within their respective schools.

Therefore, even though it is the task of the classroom teacher to implement new strategies, ultimately the responsibility lies with the principal to make sure implementation happens.

2.4.1 Principals

The duties of principals in Newfoundland and Labrador are outlined in Section 24(3) of the *Schools Act* (1997):

- A principal of a school shall, subject to the direction of the board,
- (a) provide instructional leadership in the school;
 - (b) ensure that the instruction provided by the teachers employed in the school is consistent with the courses of study and education programs prescribed or approved under this Act;
 - (c) ensure that the evaluation and grading of students is conducted in accordance with generally accepted standards in education;
 - (d) evaluate or provide for the evaluation of programs offered in the school;
 - (e) manage the school;
 - (f) maintain order and discipline in the school and on the school grounds and at those other activities that are determined by the principal, with the teachers of the school, to be school activities;
 - (g) promote co-operation between the school and the communities that it serves;
 - (h) provide for the placement of students in courses of study and education programs prescribed or approved under this Act;
 - (i) provide for the promotion and advancement of students; ... and
 - (n) carry out other duties assigned by the board.

In order to carry out these duties there are a variety of leadership strategies that are available to principals today and principals can choose to adopt different strategies depending on their purpose. The leadership style that is most relevant to this study and is actually specifically mentioned in the *Education Act* is instructional leadership.

Education reform the past decade has placed an increased emphasis on accountability measurements, specifically in the area of evaluation. The role of the principal in this standards-driven system is that of an instructional leader who “emphasizes the improvement of teaching and learning in the school’s technical core” (Hoy & Miskel, 2008, p. 433). Effective communication, along with vision, commitment, high expectations, trust, and collaboration, is a key element of effective

instructional leadership and will encourage open dialogue and actively support standards (Cross & Rice, 2000). By using effective communication strategies, the astute administrator can make a difference in student achievement by focusing on teaching and learning in the classroom.

Domenech (2002) contends that instructional leadership has now become the principal's main job and that communication and interpersonal skills are necessary for survival in today's education system. Years ago the principal was viewed as an authority figure whose demands were carried out without question. Today it is commonplace for people to question and debate actions taken by the school and comment on how such actions may affect the quality of education. As a result the modern day principal must informally communicate with members of the school community to become aware of the different perspectives that exist. By understanding the audience the principal can highlight positive elements when formally addressing the school community. As an instructional leader "you need to know what you want to say and how to say it to every audience through every means available" (p. 36).

There are several steps that can be taken by instructional leaders to improve academic achievement (Quinn, 2002). Communicating clear goals and objectives will emphasize the importance of student learning. Ongoing professional development for all staff will strengthen knowledge about teaching and learning and help to create and sustain a "culture of learning" (p. 17). Principals who reorganize their priorities and focus on what is happening in the classroom are effective at communicating the importance of learning. Finally, instructional leaders will use results as a mechanism to improve teaching and learning.

One aspect of this study deals with how principals view science education in Newfoundland and Labrador. Goldsmith and Pasquale (2002) suggest that principals can

make a difference in science education reform by learning about science education reform and “the resources needed to improve science education in their schools” (p. 25), supporting school improvement efforts, and involving parents and the community in the school science program. Principals who know and understand current challenges in science education “will be in a stronger position to promote and facilitate improvements in science curriculum itself and in its implementation” (p. 25). Although it is the work of teachers within the classroom that dictates the extent to which effective teaching and learning occurs, as instructional leaders principals can contribute to improving science education. By encouraging professional development opportunities and identifying the professional development needs of staff, principals provide an avenue for science teachers to critically reflect on current practices and learn about new and innovative teaching strategies to meet the needs of diverse learners. Goldsmith and Pasquale (2002) make concrete suggestions for principals on how to create a culture of inquiry within their schools and recommend the following structures be put in place: “common preparation times, teacher study groups, meetings devoted to analyzing student work, coaching and mentoring programs, and provisions to visit colleagues’ classrooms” (p. 27). Teachers need to feel that what they are doing is important, valued and will make a difference. By creating strong support networks within the school and district, principals can work to achieve this end. It is imperative to realize, however, that without appropriate resources teachers efforts may not be realized. Committing resources for up to date materials and technologies, as well as their “maintenance and upkeep” will help provide a challenging science curriculum (p. 28). Principals need to be advocates for teachers within the district in trying to secure funding for necessary materials in the modern science classroom.

Principals must also act as advocates for parents. Parents in general want to play an integral role in the formal education of their children, but by the time students reach junior high and high school oftentimes parents feel lost or disconnected to what happens in the classroom (Halsey, 2005). Principals can play an active role in involving parents in the science education of their teenagers by holding information sessions, allowing parents to explore science curriculum activities during a “parent science night”, providing a list of websites to parent to help them learn about current science education practices, and sharing performance data with parents and illustrating how data affects “policy, curriculum and instruction” (Goldsmith & Pasquale, 2002, p. 29).

Depending on the size of the school, principals will have varying degrees of involvement with specific departments. For larger schools it would be impossible, for example, for a principal to be directly involved in all educational departments, nor would it be effective. As a result specific departments address their own issues at the departmental level where the department head must also become an instructional leader.

2.4.2 Science Department Heads

In the school system in Newfoundland and Labrador the intermediate step between the principal and the science teacher is the science department head or lead teacher. In schools with insufficient population a department head position is not officially hired although principals will still appoint a lead teacher to carry out the same duties as a department head. As mentioned above, science department heads are another leadership position in the school since they provide support to teachers as part of the administrative team. In the data driven school system of today, they too must be instructional leaders. In Newfoundland and Labrador a department head must coordinate the effective delivery of the program of study, provide meaningful experiences for teachers’ professional development and advise the administration on policies as well as

instructional practices (Avalon East School District, 2002). In order to initiate change at the classroom level, department heads must emphasize improvements in teaching and learning, practice effective communication with teachers and administrators, be an advocate for professional development that addresses teachers personal and professional goals, and be knowledgeable about current issues and research in science education.

Zepeda and Kruskamp (2007) examined the perspectives of three high school department chairs on their roles as instructional supervisors and found:

- 1) The high school department chairs experienced role conflict and ambiguity relative to providing instructional supervision; 2) The meaning of instructional supervision for the department chairs was intuitive and reflected differentiated approaches; and 3) The constraints of instructional supervision include time and lack of emphasis (p. 44).

Although the department chairs were given a list of their responsibilities, they were not given guidelines on how to provide instructional supervision and expectations were not clearly defined. They essentially mimicked what former department chairs had done. In addition, the daily administrative tasks took precedence over a focus on teaching and learning. It is evident that the role of department chairs and department heads is critical in supporting the work of teachers and thus improving student achievement. Although teachers and administrators are all constrained by time, by clearly defining the expectations and role of the department head position schools can directly impact teaching and learning.

Zuckerman (1997) reports on metaphors used by science supervisors to describe their supervisory role. The science supervisor position in this article is analogous to the department head position in Newfoundland and Labrador since both positions aim to improve science teaching in their department which would in turn increase scientific literacy. The supervisors studied classified their role based on four functions: managerial, caregiver, political, and collegial. In terms of how supervisors can affect

change in the science classroom in particular, the managerial functions appear to be the only ones directly related to science issues in the classroom. Supervisors used such metaphors as information processor, instructional expert and teacher trainer. The political functions revealed metaphors that illustrate a more indirect relationship between science supervisors roles and classroom practices, including decision maker, educational planner, guardian of the science curriculum, science advocate and spokesperson for the curriculum. Zuckerman suggests that science supervisors should reflect on the conceptions that shape their practice and adopt a team approach focused on instruction. By developing a collaborative working relationship with teachers and promoting informal and formal discussions with teachers and administrators, science supervisors can develop a sense of community in their schools.

Science department heads themselves are teachers in the classroom, so in addition to the aforementioned roles and responsibilities, they also have the same duties as a classroom teacher.

2.4.3 Science Teachers

The duties of teachers in Newfoundland and Labrador are outlined in Section 33 of the *Schools Act* (1997):

A teacher's responsibilities shall include

- (a) providing instruction to students and encouraging and fostering student learning;
- (b) promoting goals and standards applicable to the provision of education approved under this Act;
- (c) teaching the courses of study and education programs that are prescribed or approved under this Act;
- (d) regularly evaluating students and periodically reporting the results of the evaluation to the student and his or her parent; ... and
- (g) carrying out those duties that are assigned to the teacher by the principal or the board.

The specific duties listed, however, do not give a full picture of the everyday work and experiences of teachers. Although many teachers do not view themselves as leaders in

the school system, Sato (2005) refers to teacher leadership as practical leadership “grounded in the teachers’ accounts of their everyday work” (p. 56). Teachers are leaders because their actions contribute to enhancing the education of their schools and can influence the actions and beliefs of other teachers, administrators, parents and students. Indeed, a teacher’s job extends beyond the walls of the classroom. Sato (2005) presents case studies of teachers in science education and how they employed leadership strategies to build relationships and deal with conflict. The teachers considered “the politics, the relationships, the history, the school structures, and the needs of the constituents involved” to choose the best course of action (p. 68). Their goal was to improve science education for students while maintaining a professional community in their school, which can be generalized to all teachers regardless of their subject area.

In order to improve teaching and learning, Wilmore (2007) suggests that we must focus on teacher leadership from inside the classroom. She focuses on six critical issues in education, namely vision, ethics and integrity, curriculum and instruction, equitable education, effective communication and professional development. Teachers need to develop and articulate a vision for learning within their classroom and communicate specific goals to students. In addition, students learn by example. Not only must teachers communicate these goals, but they too must follow them. As educators of youth teachers are held to a higher standard than other professionals. A teacher must be aware of this fact and ensure that his/her own morals and beliefs do not compromise the ethics and integrity of the teaching profession. Our job as educators is to use the most appropriate instructional strategies to teach the prescribed curriculum to a diverse group of learners while at the same time creating a culture and climate in the classroom that is conducive to “education for all” – certainly no easy task. Educators, therefore, must be committed to continued growth and education themselves, striving to learn the most

effective strategies for today's classroom. The role of teachers today is more complex than ever before and, in order to be effective, teachers must be willing to adapt to the changing needs of students while performing the duties prescribed by their employers.

Although the duties of teacher outlined in the *Schools Act* are general enough to be applied to all teachers, the role of the science teacher has evolved due to the goal of scientific literacy for all. To work towards this goal teachers need to take into account the individual differences of students, "their needs, interests, abilities, states of readiness, experience, and (often) sociocultural background" (DeCoito, 2006, p. 339). This is certainly not an easy task when class sizes are rising and so are the demands on the classroom teachers.

Science instruction has traditionally been didactic, viewing science as a series of facts to be memorized and the role of the teacher as purveyor of knowledge. The *National Science Education Standards* not only outlines science standards for students in the United States with the vision of scientific literacy for all, but also what science teachers should know and be able to do to achieve this goal:

Good teachers of science create environments in which they and their students work together as active learners. They have continually expanding theoretical and practical knowledge about science, learning, and science teaching. They use assessments of students and of their own teaching to plan and conduct their teaching. They build strong, sustained relationships with students that are grounded in their knowledge of students' similarities and differences. And they are active as members of science-learning communities (National Research Council, 2006, p. 4).

As mentioned earlier, teachers cannot work towards such standards without the appropriate supports in place such as time, science resources, and lower student-teacher ratios (NRC, 2006). Science education will not be effective if teachers work in isolation, therefore the entire education system needs to support good science teaching practices. In addition, students need to take "responsibility for their own learning" (p. 27).

As science educators, we are all trying to prepare students for a viable future in this competitive world. Students will face many obstacles and problems along the way and they need to be able to develop sustainable and effective solutions based on their educational background. The task of educators is to “develop an approach to the problems of mankind that considers science, the humanities, and the social studies in a manner so that each discipline will complement each other” (Hurd, 1958, p. 15). To do so, educators need to create “a more authentic, culturally sensitive and inclusive image of science” (Hodson, 2008, p.105). Hodson suggests that we personalize learning by taking into account the “knowledge, beliefs, values, attitudes, aspirations and personal experiences” of students, recognizing that science education is influenced by politics and value systems and allowing students to choose and design their own investigations (p. 105). In doing so we are creating an authentic learning environment where students are both motivated and challenged to make a positive impact in our world. Hodson (2008) identifies three elements of scientific literacy: learning science, learning about science and doing science, although traditionally the focus in science education has been on content. In Newfoundland and Labrador Core Labs and Science, Technology, Society and the Environment (STSE) components have been introduced in an attempt to shift curriculum away from this content focus and towards the application of science in our everyday lives. In doing so, students should be able to critically analyze situations that they face from a science perspective and responsibly use the modern technologies available to search for a viable solution.

2.5 Technologies in Science Education

The word technology is often used in place of science, yet according to Zeman (2005) the two cannot be interchanged. Technology is the application of science, and it is “technology that connects abstract scientific theories to the practical devices we use in

our daily lives” (p. 43). To extend this definition and give it context relevant to the present study, technologies are devices or approaches that can be used in science education to help increase and develop scientific literacy. Common technologies that have been used for decades include labs, demonstrations, field trips, and paper and pencil assignments. Although this list is by no means exhaustive, the following technologies have been implemented in more recent years and are considered to be more relevant to the science classroom of the twenty-first century.

2.5.1 Distance Education

The vast geography of our great nation poses a challenge in education since many students live in rural and remote areas where it is not possible to deliver a diverse curriculum. In response to this problem, distance education was born. Online submissions and labs allow for students in various locals to complete the exact same activity. Online streaming video and the sharing of power point attachments also allows students to receive the same content as those students who attend the traditional classroom. Programs such as Skype allow for real-time video and sound link up between students and between students and teachers. GoTo Meeting is yet another application which allows for collaboration and sharing of files in real time for presentation and collaboration classes. In Newfoundland and Labrador, several rural and remote schools are now able to offer courses online, courses that were not offered in the past due to teacher allocation. The Center for Distance Learning and Innovation (CDLI) offers over 40 high school and intermediate courses to students in Newfoundland and Labrador. Using eluminate live students meet their teachers in a virtual classroom and by communicating with a headset or through a chat room, teachers conduct their lesson online.

2.5.2 Audio/Visual Equipment

In the not so distant past, VCR's and televisions were the latest audio/visual equipment introduced in the science classroom. Nowadays teachers have at their disposal such equipment as DVD players, LCD projectors, electronic microscopes and Blu-ray players to aid in the delivery of a rich science program. From showing educational videos to tapping into the vast potential of the internet, the possibilities in the modern science classroom are only limited by the imaginations of the teachers and students within them. These devices can be used as a primary source of instruction or can provide a supplement to topics introduced in class by the teacher. As with any technology used in the classroom it is important that students know the intended purpose and outcomes of the lesson. When showing videos, animations, graphics or websites, teachers should provide performance assessment opportunities for students to communicate their understanding.

2.5.3 Smart Boards

SMART Boards were the world's first interactive whiteboards, and although they have been on the market since 1991 (SMART Technologies ULC, 2009), the education community is only realizing the full potential of this advanced technology within the past 10 years. The SMART board is a touch display that allows you to control normal computer applications from the board through the use of a digital projector. The board allows you to write virtual notes and save your work for future use. Ballard (2002) tested the interactive SMART board and described it as an "interactive teaching, collaborating and presentation tool" (p. 55). Not only is it easy to install and easy to use, the product support is timely and effective.

Several educators from a wide variety of disciplines have reported immense success with implementing SMART board technologies in their classrooms (Ziolkowski,

2004, Rochette, 2007, and Baker, 2007). The more recent literature has focused on the benefits of using SMART board technologies to aid students with learning disabilities (Mechling, Gast, & Krupa, 2007, and Campbell, & Mechling, 2009). Regardless of which classrooms are using SMART boards, their benefits are undeniable. By capturing the technological spirit within today's young people, this new technology can help to increase motivation. Starkman (2006) attributes the increase in grades and the decrease in suspensions to the installation of SMART boards in classrooms across an at risk school district in Ontario. He claims that SMART boards are essential for the "cutting-edge classroom" (p. 36). They allow teachers to animate photography; import, edit and manipulate information from the internet; create interactive lesson plans, games and homework; give online demonstrations; and aid in assessment and evaluation.

2.5.4 WebQuests

Webquests were developed by Bernie Dodge in 1995 at San Diego State University and are used in many classrooms today to facilitate the learning process. They are an inquiry-oriented lesson whereby learners obtain most or all of the information needed from the internet (Dodge, 2007). Short term WebQuests enable students to acquire and integrate knowledge whereas longer term ones help students extend and refine knowledge (Dodge, 1997). The main components or elements of a WebQuest include an introduction, a specific task, information sources, the process, guidance and a conclusion.

The learning power of a particular Webquest is only limited by how it is constructed and its intended purpose. March (2003/2004) states that "a well designed WebQuest combines research-supported theories with effective use of the Internet to promote dependable instructional practices" (p. 42). Students investigate an open-ended question, develop their own knowledge and expertise, and through group participation

they transform “newly acquired information into a more sophisticated understanding” (p. 42). March emphasizes that a WebQuest should grab students’ attention, present topics that are relevant to them, inspire confidence, and enable students to feel satisfied with their achievement upon completion. The best WebQuests are “real, rich, and relevant” (p. 46).

Some teachers have used Webquests in response to dwindling science budgets (Rasmussen, Resler, & Rasmussen, 2008) whereas others introduce this technology into the classroom as a result of low science scores on standardized tests (Wood, Quitadamo, DePaepe, & Loverro, 2007). Whatever the reason, their benefits are numerous. Rasmussen et al. (2008) used a WebQuest entitled Cell City to teach the names and functions of cell organelles to their students. Cell City enabled them to provide several levels of assessment to address various learning styles while addressing a variety of learning outcomes. In addition, students did not waste any time “surfing the net” because all links were chosen by teachers ahead of time to ensure rich and relevant material. Wood et al. (2007) also reported that by using an integrated approach to learning through a WebQuest as opposed to a more traditional one, students were able to meet more standards in a smaller time frame. In their WebQuest students had to create a hypothetical habitat outside their school to accommodate different species. By building on previous curriculum content and communicating with each other, students were engaged in “meaningful, contextual learning” (p. 25). Moreover, Webquests have the power to connect disciplines such as social studies and science which will help to motivate students and develop critical thinking skills across the curriculum (Kahl & Berg, 2006). Student compare, classify, induce, deduce, analyze, construct and abstract information (Dodge, 1997) which facilitates the development of scientific literacy.

2.5.5 Online Laboratories

The Department of Education has subscribed to eduweblabsnl.com, an interactive site for science education that is available to all schools in Newfoundland and Labrador. This site is “designed to give the student an opportunity to manipulate laboratory equipment, gather data and process that data following standard mathematical and observational techniques” (Krause, 1999). The system includes detailed procedures, pictures and descriptions of all equipment used, tutorials, blank lab reports for students to print, practice problems and games. Teachers can view individual progress of students as well as get an overall summary for the entire class.

Although virtual labs should never replace the hands on experience of working in an actual lab, these online laboratories do have many benefits in the modern classroom. Students can learn appropriate techniques for labs in a safe and controlled environment. In addition, many schools do not have the funding or space to perform specific labs; online labs would then enhance a student’s experience giving them the opportunity to work through labs that they would traditionally not have been able to perform. Many large scale scientific processes cannot be viewed in the classroom and online labs make this possible. Although many educators agree with the benefits of using online laboratories, some are skeptical of calling them actual labs since students are not physically carrying out the experiment and thus the term “virtual science experience” is preferred.

2.5.6 The Future

Technology is developing faster than the education community can process and students become technologically literate with the latest electronic equipment much faster than teachers. Cell phones, MP3 players, iPods and personal digital assistants are just a few of the handheld devices that are becoming major distractions within the modern

classroom. Berg (2008), however, is an advocate of the educational potential of such devices and urges educators to embrace these tools in the classroom. These energy efficient, mobile devices can be used for field trips, sharing data, attendance, pop quizzes, visual aids, test preparation, student progress or self monitoring, just to name a few. Berg states that handheld devices are beneficial for both educators and students since they have the potential to decrease teacher workload while, at the same time, increasing student motivation and achievement.

2.6 Issues Facing Science Education Today

Hodson (2008) suggests several challenges to achieving or realizing scientific literacy for all. Students who are socially and/or economically disadvantaged do not have the same access to advanced scientific education. Taking Berg's suggestion above, for example, not all students have access to the most recent electronic fads. If we begin to use such devices in the classroom then we either need to provide them for or students or we will be isolating students who are already marginalized. Hodson (2008) also adds that females and members of ethnic minority groups under achieve in science and tend not to continue with science education. Finally, students who do not achieve success or who struggle academically are further alienated by the complexity of science education.

Jenkins (2003) argues that school science education is limited in its capacity to promote scientific literacy because no one is sure how to realize the demands of compulsory science education for everyone. Furthermore, labs are not challenging and lab equipment does not resemble that which is used in real labs making lab work contrived and equipment inadequate. If our goal is to personalize learning as suggested by Hodson (2008), then open-ended project work is likely more effective than the contrived core labs we use today, although this suggestion is not practical based on schools' science budgets.

Another issue facing high school science education is the low level of young people entering science and technology careers (Cole, 1998). Students are not motivated to take challenging courses in high school and are intimidated by higher level learning objectives. If science programs better matched “the type of work scientists do” and informed students of how “science is practiced in business and services” (p. 620) then perhaps students would be motivated to choose science as an option for their career based on first hand knowledge rather than reading it from a book.

Many science educators claim that our curriculum is a mile long but only an inch deep. How can we expect students to delve into current science issues and concerns if we never ignite this spark in the classroom? Students are not interested in high school science due to its “historic pre-professional origins and rationale” (Jenkins, 2003, p. 272) and because it is heavily laden with facts. High school science focuses on Biology, Chemistry and Physics but if students do not fit this academic mould they have nowhere else to go. School science does not address the unknown which is what scientific research is all about. The answer to many educational issues has been curriculum reform yet many attempts at science reform have failed according to Jenkins (2003) because people have ignored the fact that science is concerned with “the natural world that stands independently of any particular human perspectives. The world of science is a mechanistic, impersonal world, and scientific concepts *per se* do not have a personal, ethical, or moral quality” (p. 274). This is not to say that science is not affected by these aspects, for it is indeed. Humans have historically studied science wearing their own biases. Values, attitudes, beliefs and morals permeate every aspect of curriculum from development to delivery in terms of who decides what is taught, how funding is distributed, how curriculum should be taught, assessed and evaluated, who should teach it and what training is required.

CHAPTER 3

Research Design and Methodology

3.1 Introduction

Before research can begin the researcher must design a plan to carry out the research based on the information that is sought. After choosing the desired methodology, participants are selected and data is collected and analyzed appropriately. Throughout the entire process the researcher must address concerns regarding trustworthiness of the data collected. In addition, strategies must be adopted to address the ethical considerations of the study.

3.2 Research Design

According to O'Donoghue (2007) the initial stage of research consists of two steps: making an observation that prompts a person to seek further understanding and formulating a research question that focuses on the issues on which the research chooses to focus. Researchers have a sense of wonder about the world around them; some focus on physical constructs whereas others prefer a more interpretivistic approach. Regardless of the field of study, the choice to pursue further understanding comes from the interests of the individual. A statement of the problem to be studied arises from the individual's inner drive to obtain knowledge.

Bell (2005) outlines a series of steps that must be carried out when undertaking a research project:

You will need to select a topic, identify the objectives of your study, plan and design a suitable methodology, devise research instruments, negotiate access to institutions, materials and people, collect, analyse and present information, and, finally, produce a well-written report. (p. 1)

Once a topic is selected and the objective of the study is determined, researchers must then decide which research approach would be most effective in getting the information

they seek. Quantitative, qualitative, action, and critical theory are examples of research approaches used in education, and although one approach may be chosen, researchers may use a blended approach depending on their purpose. Each approach has its own strengths and weaknesses and the “approach adopted and the methods of data collection selected will depend on the nature of the inquiry and the type of information required” (p. 8). For centuries researchers have relied on the scientific approach when studying particular phenomena yet Ary, Jacobs and Razavien (2002) state that there are several limitations associated with trying to apply a scientific approach when studying education. It is difficult to make generalizations about human behavior since there is a complex interaction between many different variables in peoples’ lives. In addition it is difficult, if not impossible to replicate and control educational experiments since every classroom, teacher, student and school is different. The observations made by researchers in education are subjective and the tools used are imprecise compared to scientific data collection. Finally, the presence of an observer may cause research participants to behave differently. Social scientists, therefore, needed a different approach in trying to analyze and understand the field of education and many of them turned to qualitative research methods.

Qualitative research, in particular, is used to investigate topics that are not easily studied using statistical procedures (Bogdan & Biklen, 2007). Qualitative research is an “approach to social science research that emphasizes collecting descriptive data in natural settings, uses inductive thinking, and emphasizes understanding the subjects point of view” (p. 274). The data collected provide a rich description of the situation studied and its purpose is to provide understanding about this situation. In this study a questionnaire approach was chosen to determine the perspectives of science leaders in Newfoundland and Labrador. The participants responded to a series of open-ended questions that were

sent via an email attachment; this allowed the participants time to answer the questions at their own pace and in the setting of their choice without the presence of the principal researcher.

3.3 Questionnaire Approach

Bogdan and Biklen (2007) present five criteria used to classify research as qualitative. The research must be naturalistic, concerned with the natural setting whereby the researcher becomes the key instrument in gathering data. The data that is gathered must describe the situation in words, rather than numbers, and direct quotations and emergent themes are used to provide a rich, thick description of the inquiry. Qualitative research is concerned with the process taken rather than the resulting product. It does not seek to prove a hypothesis as is suggested by the scientific method; it allows themes to emerge naturally from the data. Finally, the purpose of a qualitative research project is to provide meaning, to reveal how people make sense of the world around them.

This study uses a qualitative approach to seek the perspectives of educational leaders regarding science education in Newfoundland and Labrador. Some would argue that by nature of trying to understand their point of view we have distorted “the informants’ experience” (Bogdan & Biklen, 2007, p. 27). For this reason the researcher chose to use a questionnaire, a type of survey using questions, distributed via email attachment to all participants in order to reduce the impact of the researcher’s presence. In addition, it would be difficult, time consuming and costly for the researcher to travel to interview respondents in person across the province. The researcher felt that a questionnaire approach would be the best option based on the purpose of the study.

There are several advantages to using a emailed questionnaire. It is less obtrusive than a face-to-face interview; it eliminates interviewer bias; participants have more time to think about their responses and can respond at their own pace. Ary et al. (2002) add

that by using a mailed questionnaire participants are more likely to respond truthfully about matters with which they feel uncomfortable. Some disadvantages of using this approach include low return rate, limited generalizability, and misinterpretation on the part of respondents.

Dillman (2007) outlines that survey methodology is changing through the use of email, the internet and Interactive Voice Response (IVR). In the past cost was a major factor in determining sample size and location. Technological advances in the administration of surveys have almost eliminated “paper, postage, mailout, and data entry costs”, provide the “potential for overcoming international boundaries” and reduce the time for implementation (p. 352). For emailed surveys in particular, returns are much faster, answers are more detailed and complex and there is a lower number of nonresponse items (Dillman, 2007). A disadvantage to this method is that not everyone has email or is computer literate although this is not a major impact on the present study since all teachers in Newfoundland and Labrador have email accounts and are expected to use computers daily in their workplace.

When designing a questionnaire the researcher must decide whether to use open ended questions or closed ended questions based on the type of information that is sought. Since the purpose of qualitative inquiry is to seek the perspectives of the participants an open ended approach is much more effective. Open ended questions permit free responses, provide a wide range of responses, allow for individual time frame and are easier to construct. The disadvantages of open ended questions are they are tedious and time consuming to analyze, the responses will differ in length and the meaning of some responses may be unclear to the researcher (Ary et al., 2002).

When developing and administering the questionnaire the researcher consulted the design principles outlined by Dillman (2007). An email list was created on the

researchers personal email account so that participants' names and addresses did not show up in correspondence. An introductory email was sent to all participants outlining the timeline for the project, giving information on what to expect, thanking them for their time, and letting them know they could withdraw at any time. Once the questionnaire was emailed, participants were given alternate ways to respond, such as faxing or mailing back completed responses if email was not favorable. A reminder email was sent to participants with a replacement questionnaire attached in case participants lost or forgot about the original email. Instructions were presented clearly, pages were numbered, and participants were given space to respond freely. Once the data was collected and analyzed it was shared with participants.

3.4 Selection of Participants

The researcher contacted each of the four school districts to seek approval to conduct a study on the perspectives of educational leaders in science education. Purposive sampling is selecting a nonrandom sample "because prior knowledge suggests it is representative, or because those selected have the needed information" (Fraenkel & Wallen, 2006, p. G-6). This sampling method was used since the researcher was seeking input specifically from principals, science department heads and lead teachers regarding science education in the province of Newfoundland and Labrador. Using district and individual schools' websites the researcher found email addresses for principals, science department heads and lead teachers across the province and sent an introductory email explaining the purpose of the study and asked if they would be interested in participating. Upon receiving replies from interested individuals, follow up emails were sent thanking participants for their interest with the consent form and questionnaire attached.

3.5 Data Collection

In qualitative research the researcher can be thought of as the instrument that gathers the data whereas the participants are the direct source of data. In this study, the data was obtained using a questionnaire developed by the researcher.

Using suggestions given by Ary et al. (2002) the questionnaire began with a question that was easy for everyone to answer. In addition, questions were grouped based on similar content, and general questions were asked first and followed by more subjective ones since a “logical arrangement contributes to better-thought-out answers” (p. 397). Open ended questions were used to solicit participants perspectives in this qualitative inquiry. According to Patton (1990)

The truly open-ended question allows the person being interviewed to select from among that person’s full repertoire of possible responses. Indeed, in qualitative inquiry one of the things the evaluator is trying to determine is what dimensions, themes, and images/words people use among themselves to describe their feelings, thoughts, and experiences. (p. 296)

Open-ended questions allow the participants autonomy to use whatever words or phrases they feel are pertinent to their thoughts and feelings.

The seven item questionnaire was emailed to participants and responses were either emailed or faxed back. Bogdan and Biklen (2007) stress the importance of keeping data organized. Once responses were received, the research saved all consent forms and questionnaires on her personal computer and backed up the data on a USB flash memory. Files were named using pseudonyms. New files were created for each question so that each response and each question could be analyzed separately.

3.6 Data Analysis

Although it is now possible to use computer programs to analyze qualitative data, “the preference is for less structured, open-ended data collection with structuring taking place later through content analysis or emergent themes” (Fraenkel & Wallen, 2006, p.

462). Creswell (1994) describes the process of data analysis as “eclectic” (p.153) since there is not a right or a wrong way to analyze data. The researcher must “be comfortable with developing categories and making comparisons and contrasts” (p. 153). The challenge of the researcher in qualitative research is to take large amounts of data and reduce “it to certain patterns, categories, or themes” and interpret “this information by some schema” (p. 154). Although there are a variety of ways to analyze data, researchers are obliged “to monitor and report their own analytical procedures and processes as fully and truthfully as possible” (Patton, 1990, p. 372).

According to Bogdan and Biklen (2007) data analysis “involves working with the data, organizing them, breaking them into manageable units, coding them, synthesizing them, and searching for patterns” (p. 159). The researcher obtained 20 questionnaires each with 7 questions. To begin data analysis, 7 computer files were created containing all the responses to each of the 7 questions. The researcher then developed a coding system by reading each individual response three times and writing down words and phrases to summarize the main ideas of the response. These words provided a method of sorting the descriptive data such that material with similar ideas could be separated from the remaining data (Bogdan & Biklen, 2007). The words and phrases were grouped based on common ideas, coded using letters and the researcher identified the theme that emerged from the data. For example, after reading each response to question 1 three times, the researcher grouped all the common words and phrases, coded similar words and phrases using capital letters (S = skills) and identified five themes that emerged from the data (see Chapter 4). All seven questions were coded in the same manner, one at a time. Bogden and Biklen refer to this family of coding as perspectives held by subjects, “codes oriented towards ways of thinking all or some subjects share that are not as

general as their overall definition of the situation but indicate orientations toward particular aspects of a setting” (p. 175).

Once each of the seven questions were read and coded, the researcher noticed that some themes contained common elements across questions. The researcher then compiled a list of all themes and identified which themes repeated between questions. Again, capital letters were used to code common themes and five predominant categories emerged. The researcher went back to the data one more time to identify key concepts to help explain the predominant categories from different questions. The five categories and key concepts were compiled and displayed in a table (see Table 4.1).

Although this was a time consuming and tedious process, it allowed the researcher to become comfortable and familiar with the data, allowing the themes to naturally emerge from the participants responses.

3.7 Trustworthiness

The concepts of validity and reliability cannot be readily applied to naturalistic inquiry, although researchers still must ensure rigor in their methods. It is the duty of all researchers to ensure that the methods used to collect and interpret data are trustworthy. Upon reading a research report, the reader must be made aware of provisions used by the researcher to guarantee trustworthiness of the data. Traditionally researchers were called upon to quantify their data and report on the associated errors or statistical probabilities, which is undoubtedly impossible for naturalistic inquiry. Guba (1981) was the first qualitative researcher to present criteria for assessing whether or not qualitative data is trustworthy. The four criteria are credibility, transferability, dependability, and confirmability. These measures were applied in this study make “valid inferences from data” and to ensure “consistency of the data” thus addressing the trustworthiness of data collection and interpretation (Ary et al., 2002, p.451).

3.7.1 Credibility

Credibility refers to the truthfulness of the “researcher’s observations, interpretations and conclusions” (Ary et al., 2002, p. 451) and is often referred to as the “truth value”. The researcher must represent the thoughts, opinions, beliefs and ideas of the participants as accurately as possible and assure the reader that all efforts were made to report the true findings of the inquiry. In order to ensure credibility the researcher spent considerable time reading and coding the data and only used direct quotations from participant responses to explain emergent themes. Since the researcher was not physically on site, the influence of the researcher in participants’ responses was considered to be negligible.

Member checks is another way to ensure credibility and involves allowing participants the opportunity to verify the data and interpretations made. Once the report was finished, it was sent to participants for verification.

3.7.2 Transferability

If the findings of a naturalistic inquiry can be applied in other contexts or with other respondents, then the findings are transferable (Lincoln & Guba, 1985). Lincoln and Guba (1985) state that the individual who wishes to apply the findings of an inquiry is the person who should prove transferability, not the researcher of the inquiry. That is,

the burden of proof lies less with the original investigator than with the person seeking to make an application elsewhere. The original inquirer cannot know the sites to which transferability might be sought, but the appliers can and do. The best advice to give to anyone seeking to make a transfer is to accumulate *empirical* evidence about contextual similarity; the responsibility of the original investigator ends in providing sufficient descriptive data to make such similarity judgments possible. (p. 298)

In other words, it is the reader who ultimately determines the transferability of an inquiry.

Within the context of this study, if a reader wishes to use the findings they will prove transferability if they believe findings are applicable in other contexts. The researcher

feels that she has provided the thick, rich description necessary for anyone to make transferability judgements.

3.7.3 Dependability

An inquiry is deemed dependable if the findings “would be repeated if the inquiry were replicated with the same (or similar) subjects (respondents) in the same (or similar) context)” (Lincoln & Guba, 1985, p. 290). This quality refers to the reliability or consistency of the study. In addition, Lincoln and Guba (1985) add that demonstrating credibility ensures dependability. In order to provide a check for dependability, the researcher must make it possible for other individuals to check the consistency of results.

According to Erlandson, Harris, Skipper, and Allen (1993)

the researcher must make it possible for an external check to be conducted on the processes by which the study was conducted. This is done by providing an “audit trail” that provides documentation (through critical incidents, documents, and interview notes) and a running account of the process (such as the investigator’s daily journal) of the inquiry). (p. 34)

The findings of this study arose from participant responses to the questionnaire. The researcher kept a detailed account of all responses, ideas that emerged from each responses, and the coding procedures used to arrive at the resulting themes. Therefore, conducting an audit trail should not present any difficulty.

3.7.4 Confirmability

As stated by Shenton (2004) “to achieve confirmability, researchers must take steps to demonstrate that findings emerge from the data and not their own predispositions” (p. 63). The interpretations or conclusions made must be independent of researcher bias. Although it is impossible to completely remove bias, in order to ensure confirmability the researcher must be forthcoming about his or her own bias, give reasons for decisions made during the inquiry and report both strengths and weaknesses of the approaches taken. Erlandson et al. (1993) state that the research cannot ensure the data

are free from contamination by the researcher but must take steps that ensure that the data themselves are confirmable. According to Guba and Lincoln (1989) this means that the data “can be tracked to their sources, and that the logic used to assemble the interpretations into structurally coherent and corroborating wholes is both explicit and implicit” (p. 243). Confirmability is also communicated using an audit trail. “An adequate trail should be left to enable the auditor to determine if the conclusions, interpretations, and recommendations can be traced to their sources and if they are supported by the inquiry” (Erlandson et al., 1993, p. 35). As stated in the previous section, detailed accounts of the research process were kept by the researcher and should facilitate this process.

3.8 Ethical Issues

In order to carry out this research at Memorial University, the researcher had to comply with the “Policy on Ethics of Research Involving Human Participants” (2003) and obtain approval from the Interdisciplinary Committee on Ethics in Human Research (ICEHR), an ethics review board. Decisions made by this board are governed by the following ethical principles:

- respect for human dignity and autonomy of the person through protecting privacy and confidentiality, and free and informed consent,
- respect for vulnerable persons,
- respect for justice and inclusiveness, and
- minimizing harm, maximizing benefit and balancing risks and benefits for research participants (Memorial University of Newfoundland, 2003).

Bogdan and Biklen (2007) promote several guidelines to support ethical approaches to qualitative research which are consistent with the requirements outlined by the ICEHR.

The following procedures were used to protect participants in this study:

1. Written permission to conduct the study was obtained from the Labrador, Western, Nova Central and Eastern School Districts.

2. Participants were contacted via email and volunteered to participate. All efforts were taken to treat participants with respect and “seek their cooperation in the research” (Bogdan & Biklen, 2007, p. 50).
3. A letter of informed consent was distributed via email and participants could withdraw from the study at any point in time. The letter also detailed both the nature of the study as well as the harms and benefits associated with participation.
4. The researcher was forthcoming about the time commitment and promised to protect the identities of participants by using pseudonyms in the report.
5. Data (questionnaires and field notes) were kept in a secure location. All information collected was treated as confidential.
6. All data analysis was performed by the researcher to ensure confidentiality.

The study proposal was submitted to the ICEHR of Memorial University and approval was granted.

3.9 Summary

This chapter outlined the research design and gave justifications for the methodologies used. An emailed questionnaire was determined to be the most appropriate instrument to gather data that would satisfy the purposes of the study. Detailed descriptions were given as to how data was collected and analyzed. The issues of trustworthiness and ethical concerns were also addressed at the chapter's end.

CHAPTER 4

Analysis and Interpretation of Data

4.1 Introduction

In this chapter the researcher presents the seven open-ended questions used in the questionnaire and discusses the various themes that emerged from the data. The themes are elucidated with reference to responses given by participants. Specific categories surfaced across responses and are summarized at the end of the chapter.

4.2 Emergent Themes

This study examined educational leaders' perspectives of high school science education in Newfoundland and Labrador. Data were collect via an emailed questionnaire and each item was analyzed separately to identify underlying themes. Predominant categories emerged from the themes as the researcher analyzed each response to each question individually. Bogdan and Biklen (2007) contend that after reading through the data "words, phrases, patterns of behavior, subjects' ways of thinking, and events repeat and stand out" and the researcher must search "for regularities and patterns as well as for topics" (p. 173). According to Merriam (2009) the construction of themes or categories or findings is "largely an intuitive process, but it is also systematic and informed by the study's purpose, the investigator's orientation and knowledge, and the meanings made explicit by the participants of the study" (p. 183). Using participant responses, the researcher explains the emergent themes for each question below. This chapter concludes with a summary of the predominant categories evident in the data.

4.3 Importance of Science Education

The first item on the questionnaire asked: “How do you view science education? That is, how important is science education in your opinion? Please give reasons for your response.” All participants perceive that science education is important. Many reported that science promotes understanding, that through science education students will better understand the world around them. Beth stated that “science education provides an important understanding of various aspects of the natural world—helps students make sense of the world around them” and Ian added that “Students need an understanding of science to get along in today’s world. . . Science helps students make meaning of life.” Ian’s statement emphasizes that not only is science education is important for understanding the world, but also for finding a future in the competitive world we live in today. Participant responses reveal the significance of science education for the future, that is, what benefits students will incur as a result of taking science courses. The specific themes that emerged from this question include:

- development of skills;
- impact on society;
- informed, scientifically literate citizens;
- technological advancements; and
- higher education and workforce.

A discussion of each theme follows.

4.3.1 Development of Skills

The majority of participants are of the opinion that science education helps student develop skills that they will carry with them throughout life. Skill development included such aspects as decision making, critical thinking, being able to learn

independently and problem solving. Julie revealed that by developing decision making skills, students will be better prepared to make decisions regarding their health:

If students have a science background, then as adults they will be able to make informed, intelligent decisions about issues which affect them on a daily basis. These could include decisions about something as simple as whether or not to smoke, to more complex decisions such as those involving reproductive technologies, health care treatments, etc.

Sam added that it is through the development of critical thinking skills that students will be able to think independently rather than just memorizing information: "More importantly however is that we provide students with the tools to find answers when needed and to analyze scientific issues. We should train students to think about science, not just remember facts and formulas." If students can think about what it is they are doing, they will not blindly accept information as being truth. Rather, they will seek proof and validation in matters that are of significance to them.

Frank, who works as a science specialist, reiterated the importance of the development of what the researcher has labeled science skills:

Science education is critical to the development of every individual because it promotes critical thinking and independent learning. As educators we want all of our students to be lifelong learners. Science education, through its inquiry, problem solving, and decision making strategies, enables our student to be very well equipped to be lifelong learners.

Not only will science education help students individually in their continuing education but having an educated population with well developed science skills will benefit society as a whole: "the principles and processes students learn will provide them with the skills necessary to function in the society of tomorrow and to develop products that will make our lives better" (Nate).

4.3.2 Impact on Society

The actions of humans have no doubt placed several scars on Earth. Several participant responses alluded to the impact that science has had on society, both positive

and negative: "Many aspects of our life are influenced by science, such as health care, employment, life style choices and the environment ...Students should also be aware that there are both positive and negative aspects of most technologies" (Julie). Science has improved "our quality of life" as stated by Ian, but if we do not also educate our students about the problems that face our world then humankind is in trouble. The students of today are the researchers of tomorrow that will work to find solutions to global warming, environmental disasters and disease. "If science education fails to inform and enlighten our students, it fails our society generally" (John). By understanding how science impacts society students can be part of the solution to many of the world's problems:

The world's greatest problems today, in my opinion, are global warming, sustaining populations, and Environmental disasters (i.e. mismanaged landfills, worldwide). Accordingly, Science Education is also important in that the world's current greatest problems (beyond economics!) were created by ignoring Science in the past, and it will be Science and Science only which will solve these problems. We must educate our youth with the errors of previous generations and then empower them with the Science skills they will need to solve these problems. (Ben)

Society needs science minded individuals in position of power in order to impact society in positive ways: "...given the current emphasis science in international policy (for example, global climate change) it is important that governments employ people with a solid science background to be part of the planning and implementation of policies addressing these issues" (Jill). Nate alluded to the fact that if students have a solid understanding of the impact that science has on society then they will be more proactive in their use of science and technology:

I think it is very important for every student to graduate with a good understanding of science, science concepts, and the impacts of science and technology on our world and society. ... Many of the problems we face today are related to our use (or misuse) of science and technology. For example, the provision of sufficient food and clean water for people can be assisted through the use of science.

The misuse of science in the past has left humankind with dilemmas in terms of the appropriate use and resulting effects of science and technology. Nate stated that we can use science to help solve our problems, but we can also look at our misuse of science in the past and reflect on our actions in the future.

4.3.3 Informed, Scientifically Literate Citizens

A third theme that emerged from the responses was the idea that science education is important because it creates citizens who are scientifically literate and capable of making informed decisions regarding issues that affect humankind. Leo simply stated that science education “Helps create better citizens” whereas John elaborated on his thoughts:

Science education is critically important for all citizens. Whether our students pursue science at the post-secondary level or not, all of our graduates need to have a high level of scientific literacy in order to understand and make decisions regarding major issues of our time.

Joe defined what he means by scientific literacy and suggested that people will make decisions regarding their health and the environment based upon their knowledge of new scientific innovations: “...to be scientifically literate means that people will better understand modern technologies, new scientific developments, etc and how these can help improve the quality of their lives, especially as they apply to our health and the environment.” Jill emphasized that it is important for all citizens to have a general understanding of science and science related concepts in order to evaluate, judge, and make decisions about science and technology:

an understanding of the nature of science (what it is and what scientists do) is essential for the general population to be able to evaluate and make decisions on issues with a science perspective. ... The importance of a scientifically literate general population might not be as obvious but is just as important. Increasingly, our society relies on science and technological applications in our everyday lives. We are constantly confronted with media reports and government news releases that relate to issues such as climate change, ethical considerations in medical procedures and technological advances. Additionally, many consumer products

include claims that require an understanding of 'scientific testing' in order to be effectively evaluated by the consumer. Citizens must be able to judge for themselves the merits and values of scientific claims and resulting policies.

4.3.4 Technological Advancements

Several participants spoke of technology as either being synonymous with science or an integral part of science education. The fourth theme that emerged from the data is importance of technological advances and applications in our lives. Julie used the term technology in place of science and stated that is important for students today to understand technology more than ever because we use modern technology in almost every aspect of our lives:

As well, technology is also a part of our lives today, more so than in any other generation. It's important for students to have an understanding of technology, as today we use it for communication, transportation and even in our home appliances, to name just a few examples.

John and Nate both implied that in order for society to keep abreast of the advances in modern technology, students need a solid background in science. John commented that "Considering the rapid pace of scientific and technological advancement, the importance of science education is obvious." Nate added that technological advances come from scientific understanding: "Science forms the basis of all technological innovations and a sound understanding of the scientific principles provide us with a better understanding of the technology we use." According to Ben, the comforts that we enjoy today due to the application of technology would not be possible without science education:

Science is the basis for new technologies which we appreciate every day. Whether it's the garbage truck that collects the trash or the miniscule mp3 player which we enjoy on an evening jog, we rely on these 'technologies' to make our life easier and happier. Whether these technologies are old or new, we can trace them back to a basis in some form of science or another.

4.3.5 Higher Education and Workforce

Although not mentioned by as many participants the researcher felt it was important to note that higher education and workforce emerged as a final theme in communicating the importance of science education. One purpose of education is to gain meaningful employment in the future. Some participants agreed with this statement by stating that science education is important for the future education and employment of our young people. Carl and Henry mentioned specific careers that require a background in science. Carl stated that “Science education is very important in today’s world of increasing technology and increasing science related occupations. Different types of mining, oil and gas research, etc. all require different types of science education.” Henry remarked that “Whether we agree or not most students will work with technical language and mathematics, as professionals, secretaries, lab technicians, etc.” Joe, on the other hand, focused on science education as being a stepping stone to pursuing further education towards a career path stating that science education “ensures that students have the background knowledge to further their training and education in one of the many growing career(s) that (are) in science/medicine/engineering.”

In order to compete in the global marketplace students need to develop critical thinking and problem solving skills that they can adapt to the changing demands of society. Science education provides students with this opportunity. With a solid foundation of science skills in high school, students are more likely to succeed in post secondary institutions and beyond. Adam emphasized this point in his comments: “If you want to have a chance at a good post secondary education then you need a good science high school education.” Finally, Jill stressed the need for highly educated individuals to pursue careers in science, technology, engineering and mathematics, specifically in the area of research and development:

... solid science education is required for those who choose to pursue higher education and careers in the field of science. ... There is a global shortage of individuals in pursuing education that would allow them to participate in STEM careers. We need highly educated individuals in research and development.

4.4 What is Scientific Literacy?

Participants were also asked to define scientific literacy and four themes were evident throughout the responses:

- foundation knowledge and understanding,
- science skills and processes
- literacy and communication, and
- application to life.

A discussion of each theme follows.

4.4.1 Foundation Knowledge and Understanding

The most common theme that emerged from the definitions provided was foundation knowledge and understanding. Participants are of the opinion that a scientifically literate individual should have some background knowledge in the sciences, a working base of information, and the individual should then be able to understand science concepts and their applications based on this foundation. Edna commented that scientific literacy was to “have some knowledge of the concepts in Science” and Sam added: “To me it means having an understanding of scientific issues and concepts.” Carl’s definition specifically mentioned the understanding of science terms: “Science literacy, to me, means being able to understand scientific terms and topics.” And although Ian also highlighted terminology, his concept of scientific literacy was unique in that he added the qualifying statement that scientific literacy depends on the individual’s ability: “Scientific literacy means that a student has a working knowledge of science at

their own level of ability. This means that they have appropriate knowledge of scientific terminology, an understanding of at least basic scientific principles.”

Science is a very broad subject area and includes such disciplines as biology, chemistry, earth science, geology, and physics. Although it is impossible to study all disciplines, Nate perceives that it is important to understand the general concepts in each: “To be scientifically literate a person must understand the basic processes of science and have a general understanding of general science concepts in the various subdivisions of science.” Greg added that scientific literacy is “Basically a working knowledge of science, it’s process(es) and applicable laws.” Jill did not mention the various disciplines of science, but she also perceives that it is important to have a general understanding of science. Jill’s definition implies that it is not imperative that one knows the different concepts from different disciplines, but rather knows how to gain this knowledge and evaluate it: “To me, the term scientific literacy refers to an understanding of what science is, what scientists do and how scientific knowledge is gained and evaluated.” If someone knows how to find information and critically analyze and evaluate it, this individual can learn independently.

The remaining comments that support this theme focused on how the foundation knowledge and subsequent understanding affect everyday life: “Scientific literacy means having background to understand how science plays a role in our everyday life” (Mary). Julie is of the opinion that individuals should understand how science affects them: “To me scientific literacy means having a basic understanding of science and technology and how it would affect an individual.” Both John and Juanita linked their definitions to applications in the real world. John focused on advancements in science as revealed by his comments: “Scientific literacy means the ability of a person to make sense of scientific issues and to understand the implications of scientific advancements” whereas

Juanita stressed the importance of being able to make sense of situations in the real world. According to Juanita scientific literacy “is being able to understand why and how things happen in a real world sense. E.g., why there are so many potholes in the spring; why a tv ad which advertises O_3 in a product is nonsense.”

4.4.2 Science Skills and Processes

Another strong theme that emerged from the majority of participant responses was science skills and processes. Participants discussed the development of skills as was present in question 1, skills such as critical thinking, problem solving, decision making and inquiry. According to Frank, an individual who is scientifically literate can use these science skills and be able to explain phenomena to other people:

A person who is scientifically literate is one who is able to use inquiry, problem solving and decision making skills in their everyday life. This person is able to think critically as to why and how things happen and able to effectively communicate to others why and how things happen.

This theme not only includes being able to critically analyze and evaluate a situation, but also being able to perform and carry out experiments using the appropriate lab techniques and equipment. Ian stated that scientific literacy is “an ability to perform in the lab with guidance where necessary” recognizing that scientific literacy does not imply all-knowing, rather that we have the skills to be able to find out how to perform the processes required. Leo added that an individual who is scientifically literate should be “able to use the tools of science.” Once process skills are carried out appropriately, a scientifically literate individual should then be able to process the information gain and make appropriate decisions based on the data. According to Julie, scientific literacy means being “... able to make informed, intelligent decisions about the information. It would also include being able to perform the basic scientific processes such as classifying, predicting, measuring, interpreting, etc.” Ben also believes that a

scientifically literate individual should be able to make sense of the information acquired and be able to explain their perspective to others, “to develop a well-founded opinion or argument on a certain science-related subject.”

Scientific literacy has evolved from a simple concept, to multiple definitions and meanings, to the goal of modern science education. Nate is of the opinion that scientific literacy is never achieved, rather it is something that we as educators should always strive towards: “Scientific literacy is not an end so much as it is a process; a combination of attitudes, skills, and knowledge which we need to develop problem solving, inquiry, and decision making skills that we use in our everyday lives.” Perhaps Jill’s response to this question sums up all the main points of this theme. Her comments reveal the importance of scientific literacy – being able to think critically, analyze a situation, perform process skills, and evaluate the outcome of a situation with reference to its place in society:

... scientific literacy includes content knowledge, process skills (for instance observing and interpreting) as well as valuing open and honest communication of experimental results. As an example, when an individual is scientifically literate, they possess the skills to take the information presented in the media and evaluate its impact and importance to society. They are also able to distinguish between questions that can be explored by science and those that cannot be explored by science.

4.4.3 Literacy and Communication

A third theme that emerged from the definitions is that of literacy and communication. The term literacy in this sense means being able to read, write and understand information whereas communication involves both listening and conveying information to others. Some of the responses given by participants focused on the literacy portion of the definition, as is evident from Julie’s response: “It means being able to read, understand and learn about science and technology.” Although Ben was unsure of the meaning of scientific literacy, he too spoke of literacy as it applies to science: “I

suppose it means a person being able to read a science-based story and have an ability to understand it.” Other responses focused on being able to communicate with others using science language and defined scientific literacy as “the ability to communicate effectively about the world around us” (Frank), “being aware of the language of science and how to use it” (Leo), and “the ability to take part in a discussion, or listen to and understand a discussion, pertaining to a scientific concept” (Greg).

Other participants elaborated upon their definition and chose to include reference to the importance of literacy and communication in our daily lives. Juanita perceives that it is important for the general population to be able to communicate, read, analyze and acquire science knowledge: “People should be able to have sensible discussions with their doctors, read reports in newspapers and judge their validity, know – or be able to find out – the effect of using pesticides on their fruits and vegetables.” Carl also mentioned communication and reading comprehension in his definition:

Having a well rounded science education will allow someone to have a broad idea of these topics/terms so that they can have an understanding of an issue whether it be in the workplace or simply in a conversation; reading a newspaper, etc.

Beth also added the importance of being able to ask intelligent question in addition to being able to read, listen and understand with confidence science concepts:

To have the ability to engage in meaningful discourse on a variety of issues – that involve science – that impact society. ...To be able to ask good questions about scientifically-based phenomena or issues. At its very basic, to be able to pick up a newspaper, magazine, or to watch or listen to television or radio that involves science, and to attend with confidence to the issues with some understanding and certainly the ability to ask questions.

Regardless of the definition, the importance of literacy and communication is evident in many aspects of our lives, not only those pertaining to science education.

4.4.4 Application to Life

Although alluded to within other themes, the researcher felt the need to separate application to life as a final theme present in the definition of scientific literacy. Many responses given by participants singled out the application of science to life situations as being separate from knowing and understanding science concepts, having science skills, performing science processing and reading and communicating scientific phenomena. According to Mary, students may not see the relevance of what they are studying right away; in fact it may take years for them to appreciate how science applies to everyday living. In her words: 'Often, students will ask "Why are we learning this?" Within a few years of graduation, those same students tell me that something we studied in science helped them to understand a life situation better.' An aspect of scientific literacy is having an appreciation for how science applies to us, or as Leo stated "understanding the role of science in our life." Scientific literacy is to have "a great knowledge of science concepts and be able to apply this knowledge in real life situations" (Adam). Not only will people be able to understand and apply this knowledge, they will be able to explain science phenomena in their lives as evident in Eric's response: "People can use principles grounded in the sciences to help explain their world."

Life is constantly changing as society struggles to keep up with advances in science and technology. Being able to adapt to these changes is something that science students need to be cognizant of in order to be successful. Scientific literacy also pertains to understanding the nature of science as a changing and evolving discipline. As Jill explained, an "aspect of scientific literacy would include an understanding of the nature of science and how scientific knowledge evolves and changes as phenomena are studied."

4.5 Issues Facing Science Education

The third question asked to participants was “What are the major issues facing science educators in Newfoundland and Labrador? Please list practical examples that you might recall.” Due to the broad nature of this question the researcher anticipated a large variance in the data. Responses to this question were longer than those given to the other six questions. Despite the lengthy responses, the researcher identified six main themes, including:

- curriculum,
- time constraints,
- teacher workload and stress,
- teaching training,
- focus on the learner, and
- inadequate resources.

A discussion of each theme follows.

4.5.1 Curriculum

The theme that was evident in the most responses was dissatisfaction with curriculum. Participants feel that the curriculum in Newfoundland and Labrador is too broad, contains too much material and does not contain sufficient links to local interests. In addition, some participants are disappointed in the amount of science curriculum that is required for graduation from high school in this province. In addition to these frustrations, Julie is also less than impressed with the text books chosen by the Department of Education. Her thoughts were:

Many of the courses which are being taught are not relevant to our province (although there has been some improvement in recent years...Science 1206, 2200/ 3200) I fail to understand why the Dept. of Education comes up with a set of curriculum outcomes and then cannot find (or better yet produce) a text book which matches the outcomes. Teachers do not have the time to go and look for

material to cover the outcomes. As a result, outcomes not covered in the text are often omitted.

A significant complaint about the curriculum was that it contains too much material as evident from the responses listed below:

- “Too much material to cover” (Edna);
- “The curricula are jammed packed and repeated for the most part, especially in jr. high.” (Greg);
- “the content is too dense – too much content without time to explore the underlying issues or to go off on ‘tangents’” (Jill)
- “dealing with the crammed curriculum is a big issue. The new science curriculum is jam packed with material, most of which is given a cursory treatment” (John).

There are negative by-products in having an overloaded curriculum. Teachers cannot spend time on topics that interest them or students since content has to be “covered” in a timely fashion. This may de-motivate some students from taking science. John added that the “fast pace required to complete the courses places the weak academic students at high risk of failure. This may be one reason why enrolment in the general science courses is far too high.”

In addition to the amount of material present, some participants are of the opinion that the specific content in the curriculum should also change. According to Sam we “need a current and adaptable curriculum.” By keeping curriculum material up to date students are better prepared for post-secondary institutions and the workforce. This will not only keep “science education relevant for students” (Leo) but will also motivate students to choose science as a career option. According to Jill:

Students do not see science as a career option. We have been focused on skilled trades for a long time...the shortage in Science Technology and Engineering careers is just as important yet we fail to encourage students to pursue these. We

should be addressing the impression students have that these careers are dull and leave no room for creativity.

As mentioned above, some participants are concerned with the graduation requirements as set out by the Department of Education. They believe that students do not get enough exposure to science due to the low number of science courses required for graduation. Leo stated that educators should encourage “students to take more than only the required number of science classes” but Henry implied that the Department of Education could be doing more to ensure an enriched science curriculum experience for high school graduates. He commented that a “graduation from high school only requiring 4 science credits is an absolute travesty.” Jill also feels that the graduation requirements restrict students. She stated that:

high school graduation requirements make it very difficult for students to fully explore science in high school. For instance, it is next to impossible for students in small schools to take Bio, Chem and Physics in levels I to III. Try adding in Earth systems or Environmental science and it becomes even more difficult. (I had students who had to drop level III Chemistry because it was offered at the same time as Human Dynamics 2200 which they needed to fulfill the ‘other required credits’.) Why can’t they use a science course as ‘other required credit’?

Ian specifically mentioned Science 1206 as an impeding factor in the curriculum. This course is relatively new in Newfoundland and Labrador and all academics students must take it to graduate. Science 1206 contains four units on Biology, Weather, Chemistry and Physics and is meant to provide background information in these major content areas so that students can prepare for other optional science courses. In Ian’s words:

This course, while a good one, restricts a student’s ability to pursue all 3 academic streams (Biology, Physics, Chemistry) because it has to be taken before Physics or Chemistry can be done. It is better suited for Grade 9. This affects science teachers at the High School level because they are somewhat restricted in terms of their ability to reach a maximum number of students.

It is significant to note that both Frank and Nate, who work in directors positions as defined by the researcher, did not feel that the curriculum itself is an issue for science

education. Rather their concerns are with how material is presented. Both Frank and Nate would like to see a more hands-on approach to science education. Franks stated that "Science educators need to be able to provide our youth the opportunity to "do" science more often" and Nate would like to see educators:

Covering the content in their courses in a hands-on manner. Too many teachers focus on the content and feel that it can only be "covered" if they provide students with written or electronic notes. It is a challenge for them to embrace experiential approaches.

4.5.2 Time Constraints

When asked about the major issues facing science educators, Ian and Eric simply stated time and Greg emphasized his point using the word processor – "TIME!!!!!!!!!!!!!!!" he exclaimed. Many participants feel that they do not have enough time to cover the curriculum, do hands-on activities or set up labs. Julie commented that she would like to do more activities in her classroom, but with all the interruptions within the school year and the amount of material to cover she struggles, even as an experienced educator. In her words:

I would say that the major issue facing science educators in our province today would be a lack of time. As a science teacher for the past 25 years I find that there are many things which I would like to do in the classroom, but which I am unable to do as I simply do not have the time. I try to do as much lab work as possible in each of my courses, but setting up, performing and evaluating lab work takes up a considerable amount of time. Too often, labs which are prescribed for a course do not work out as they were intended. ... Also, most courses are overloaded with material which cannot possibly be covered adequately in the time constraints of the school year. A significant amount of time is lost throughout the year due to weather, outside agencies which demand access to schools, and other school activities such as winter carnival, etc.

Carl also commented that interruptions to regular teaching impedes "proper" teaching:

Too much information and material in the academic courses for teachers to do in a 10 month course. With so much effort being put into "just finishing" the courses (especially level III public exam courses) there is little time left to dwell into certain areas, prepare students for exams, do labs, etc. Time is not there for proper teaching. Time missed for co-curricular activities; exams, weather closures, etc. reduces the time needed to properly teach the course.

All teachers need time to prepare for classes, not only science teachers. Even as a principal Edna recognizes the “lack of prep time” available to teachers. An extra time constraint dealing with preparation that is exclusive to science teachers, however, is the time required to set experimental stations for students, ensuring everything works properly and that the lab environment is safe. Beth commented that in other countries teachers have technicians to help them. Her concerns are that there is a:

Lack of understanding or lack of the willingness to venture into the political quagmire – that science teachers need ‘more time’ to set up labs, particularly at the high school level!! In the UK, schools of a certain size have technicians to help set up labs.

Both Frank and Nate would like to see more hands-on activities, but Jill stated that the reason why science teachers do not perform more hands-on activities is that there is not enough time:

... not enough time in elementary and intermediate grades to really get into science (the department assumes we have 100 hours when they develop curricula but very few schools actually have that much time...in fact, if we teach the 10% required, we only have 84 hours.) ...science department heads/teachers are not allotted any additional time to prepare for labs. (I have six hours of prep in a 14 day cycle. I teach 6 different courses – for each course, that’s one hour of prep per cycle. All the safety concerns and issues with the lab must also be done in that time frame). I believe this is a big part of why teachers may not be doing all the ‘hands on’ activities they could be.

Frank acknowledged that even though there are ways to improve teaching and learning, time is one obstacle that prevents educators doing so:

Our science curriculum allows for many opportunities to enhance teaching and learning but quite often there are obstacles preventing this from happening. Some of these obstacles are teacher training, scheduling of the school day, time allocated for science, and many other infrastructure concerns.

4.5.3 Teacher Workload and Stress

Another major issue that science educators felt that they face is the increased workload and subsequent stress of their job. Within this theme there several examples listed that contribute to workload, including class size, classroom management, course load, extracurricular duties, and expectations from the Department of Education.

Workload and stress are not specific to science education, although the stress associated with lab preparation is unique to this field. Some participants believe that safety is an issue in the lab due to increased class size. Large classes are more work and the stress associated with having upwards of 35 students in a lab often means that teachers perform demonstrations rather than allowing students to carry out the lab in groups. Beth, John and Nate all quoted lab safety as a major issue in science education due to class size.

Beth would like to see a cap placed on lab courses: "There are no 'caps' set up on labs from a safety point of view, as there are in tech and shop classes." John fears that lab work is left out as a result of safety concerns: "In some instances, class size is an obstacle for lab work. If class size exceeds the maximum space available in a laboratory, safety issues arise that may cause lab work to be curtailed or eliminated." Finally, Nate specifically addressed the issue of stress associated with large lab classes:

Having appropriate class sizes to permit more hands-on (laboratory based) learning. Class sizes over 24 make some labs difficult to do and others more dangerous. I believe there is a significant level of stress among science teachers who are contentious and try to complete all core lab activities.

Although Ben does recognize the efforts made by the Department of Education and the School District to increase lab safety, he too believes that there needs to be a cap on class size for science courses:

The Provincial government has paid for lab chemical disposal of late, and our District has also assisted. This is an invaluable step towards sustainable Science lab safety. There has also been the addition of lab coats, lab goggles and goggle disinfecting cabinets. This, again, has been an invaluable cost savings to allow

safer labs in schools, and is greatly appreciated. There has been an identification that acid cabinets need to be purchased / replaced and then correctly installed (I've yet to see correct installation of this in any high school chemistry lab); this process appears to have stalled. There is another key element of lab safety missing: minimum class sizes in lab science courses. This has been completely overlooked, and cannot be overlooked any longer. Courses sections, in city schools at least, may be in excess of 30 students per section, inasmuch as a regular classroom is expected to handle such numbers. Yet, in a working lab setting, class sizes in excess of 30 students, simply put, it a safety hazard for the lab floorspace in any school I have been in. This must be addressed ASAP; lab classes above 30 students, regardless of other measures which have been taken, are accidents waiting to happen.

In addition to overcrowded labs, Julie stated a number of issues that contribute to her increased workload such as discipline, teaching new courses, and extracurricular activities. In her words:

Often labs are overcrowded and safety is an issue. In junior high grades, behaviour/discipline is often a problem, particularly for younger, less experienced teachers. . . I am currently on a year's leave of absence through deferred salary. When I return to my position, I will likely be responsible for at least two junior high sciences and the corresponding health courses. All of these courses will be new to me and in addition I will have Science 1206, 3200, Biology and likely Human Dynamics. On top of that there are extracurricular expectations, as well as the operation/maintenance of the lab (for which I receive no additional pay/prep time).

Juanita's comments reveal that she personally feels bad about not having more time to try different activities. Her issue is "overwork" and she elaborated by saying:

Our curriculum is jam packed, the demands of our jobs keep increasing. We cannot do the "interesting" things – field trips, demonstrations, discussions – because, more often than not we don't have the time or energy to prepare and present these. We'd love to, but we can't.

Perhaps the most developed answer to the third questionnaire item came from Ben. Although he agrees that class size is a major issue, he added that the Department of Education places large expectations on teachers to carry out alternate forms of assessment without adequate support. He would like to see more teacher input in the development of course descriptors:

Since I have become a full-time Science teacher in the last 12 years, I have seen the District become more and more involved in taking an active role in Evaluation of Science courses. In some regards, this is necessary and done in the appropriate fashion. Course Descriptors have been developed and modified several times over in this timespan, with the main focus of these descriptors always falling on the weightings of each element of evaluation through the school year. I understand the reason for this – wanting consistency in evaluation of a course through the District – yet there are elements to this which do not assist in a teacher's ability to deliver a course in the best possible way. These course Descriptors often legislate exams or no exams, and a percentage on "Alternate Assessment" which teachers are not comfortable with. Regarding the Alternate Assessment, it is my opinion that the District is using its common descriptor to force teachers into doing a large degree of Alternate Assessment... this is not always easy to do within both the specific course curriculum objectives AND the timeframe we have to properly deliver these courses. Accordingly, teachers who would wish to do many forms of Alternate Assessment still feel like they are doing an inadequate job of one form of assessment at the expense of the other, and overall the delivery of the course often suffers: the opposite effect that the District appears to be trying to accomplish. In the past, the District has both tried to solicit teacher's opinions on course descriptors and have tried to almost sneak new descriptors by teachers without allowing them any input. Obviously the latter is no way to bring about policy, no matter how difficult it may be to reach a consensus should the District properly seek teacher input. In the future, should the District stay in the business of legislating a course descriptor on its teachers, it better not destroy teacher morale by not consulting with teachers before presenting a new descriptor.

4.5.4 Teacher Training

Several educational leaders perceive teacher training as a major issue in science education. This theme encompasses not only pre-service teacher training but also the professional development of teachers in the field.

Both principals and department heads that participated in the questionnaire believe that there are not enough trained science teachers, that teachers who do not have specialist training in the sciences are not qualified to teach science. In Jill's words: "a lack of understanding of the nature of science when generalist teacher lacks the educational background or professional development to teach science as anything but a collection of facts that are 'true' and always will be." Sam stated that "Teachers should be specialists in their areas." Dan, who is a science department head, and Eric, who is a

principal, are both of the opinion that not only are specialists needed at the high school level, but also in the elementary sciences. Dan's issue is that there is "unqualified teachers in science especially at the elementary school level!" Eric questioned the "Science competency in teachers at the primary /elementary level" but also added that "in-service training in: Current curriculum, Current issues/practices in science, Efficient use of technology, Assessment / Evaluation" is needed. As a lead teacher in the field, Julie revealed that there are extra factors to consider for science teachers in rural schools. Not only do they not have sufficient training, but there are no specialists near by with whom to consult. She stated:

Also in many smaller, rural schools the "science" teacher often has little science background. Let's face it, no one can be an expert in all sciences, but the junior high sciences are often given to teachers with little science background (also confirmed in my thesis research). In some schools there may be only one "science" teacher and there may not be any one with whom to consult. Yes, there are board personnel, but they are not always available. The Internet would probably be a science teacher's greatest asset today.

Adam and Ben both feel that we are not retaining trained science teacher, but both gave different reasons for this shortage. Adam believes that there is little incentive for science teachers to work in rural Newfoundland and Labrador, as echoed in his response:

The major issues in our school is the lack of trained science teachers. Because of the remote location it is difficult to attract science teachers because there are not enough of them and they take the jobs in larger areas. WE need to provide more training on site to teachers who are teaching science and have very little if any background in it.

Ben stated that it is difficult for young trained specialists to find work in our province and they are leaving as a result:

Trained teachers have been somewhat accessible by the system, yet many very well qualified young teachers have had to leave to other regions of the country for full-time employment, given the way in which hiring is currently done by our school Districts. Please understand that the Districts are not, in my opinion, completely at fault when it comes to not hiring excellent young teachers; the Collective Agreement of the NLTA plays a role in this as well. While there may be abstract mechanism(s) in place allowing younger, enthusiastic well-qualified

teachers to be hired, we need a real, “accessible” mechanism to allow this to occur in some equitable way. I realize this may be very hard to design... it is just a shame to see many of our best young teachers leave, as they cannot wait for forever to start a full-time career as a science teacher.

Once teachers do secure work in our province, it is important that the respective school boards ensure sufficient training for teachers to keep up with modern technologies, teaching strategies and innovative activities. Ian commented that in order to provide the professional development needed “more substitute days (are) needed.” Teachers need to be “keeping up with the latest research in their discipline area. To keep their enthusiasm and the content they teach “fresh”, teachers should know of current research” according to Nate.

4.5.5 Focus on the Learner

A fifth theme that emerged from the data focuses on the learner. This theme has two dimensions. The first dimension is the work ethic of students today is an issue in science education. Dan simply stated there is a “lack of work ethic by students” and Edna added that there is a “lack of interest from students.” Juanita believes that parents also contribute to the low efforts of students. Her issue is with the “apathy among students and parents.” She continued by saying: “People fail to recognize that science, as with most things, is hard work. They’re not willing to put in the effort to achieve.” Mary chose to take a positive approach to the question and offered a suggestion as to how she deals with unmotivated learners: “One of the major issues facing science educators is to make science interesting and applicable to the students. When I use examples that students are familiar with, they become more interested into understanding the theory.”

The second dimension within this theme is addressing the needs of the learner, that is recognizing that the modern classroom contains students with varied abilities. In Nate’s words:

As with any other teacher, I think that addressing the myriad of needs in their classroom, of making their classroom inclusive, is a significant issue for science teachers; particularly those who teach subject that have more heterogeneous populations (e.g. junior high science, Science 1206, Biology 2201).

Julie added that this diversity contributes to the time needed to cover curriculum content.

She also revealed that students are not motivated to do homework, which links to the first dimension mentioned above:

One must also take into account the differences in student abilities. It's fine to say that a particular unit of study may take 30 hours, but sometimes the class ability is such that this is not the case. Add to that the growing phenomenon that students do less and less homework/study. In the past 25 years I have seen a significant decline in the amount of time that students spend on their studies. Homework appears to be a thing of the past.

The geography of our province also adds another element to this dimension since many of our modern classrooms are rural. Not only are teachers trying to address the needs of diverse learners in the same course, but some rural teachers have to teach science in a multi-age setting. According to Jill, teachers need more support in these situations in order to focus on the learner:

There is a serious lack of consideration for the needs of rural educators and students. For instance, many small schools address the science curriculum in a multiage or multigrade setting. There is no consideration of this in curriculum documents and very little (if any) guidance in terms of professional development. It is as if the dept and our school districts believe that the single graded classroom is the only type of classroom and that we are all teaching in St. John's or Corner Brook. This is not the case.

Sam simply stated that "Students in smaller and rural schools should have equal opportunities." Just because students attend a rural school, they should not be disadvantaged in their science training.

4.5.6 Inadequate Resources

A final theme that emerged from the responses to the third question was there are inadequate resources available for science educators. Inadequate resources includes outdated equipment, insufficient equipment, and a lack of funding. Edna stated that there

is a "lack of money for equipment" and "outdated equipment" that needs to be replaced. Leo would like to see more funding specifically for "technology to better show science." Not only would funding help educators purchase up to date equipment, but it would also allow teachers to try new activities with students, activities that would otherwise be impossible. As Ian stated: "More money would bring benefits such as improved resources (lab equipment for example). It would also enable teachers to travel with students for enrichment activities." Presently the amount of funding received by schools is largely dictated by the school population. This mean that larger schools have a larger science budget. According to John, not all schools have equal opportunity to get the materials they need to complete core labs: "Access to materials for the science courses varies from school to school. Laboratory equipment is needed for the core lab activities. From what I gather, some schools are lacking in this regard." Sam reiterated this point by stating "The resource budget should be sufficient to cover program needs." Julie actually completed graduate research on this topic and found that smaller schools do not have the same equipment supply as larger schools. She stated: "In many smaller schools the equipment is simply not available. (this has always been a pet peeve of mine and I confirmed it during my thesis research...some schools could place all of their science equipment in a large toolbox)."

In recent years the Department of Education has put more money into science education and in fact purchased a large quantity or equipment for schools. Both Ben and Julie are thankful for this support. Ben would like this support to continue and suggested that teacher be consulted regarding what supplies are still missing. His comments were:

There have been an influx of resources provided to schools by the Department of Education in the last few years, and we are very grateful for this support. We have received hot plates, thermometers, burettes, microscopes and weather stations. The list could continue on. What we need now is the remaining 'blanks' filled in our inventories, and the Department / Districts should consult teachers to

see what remains to be stocked, should this process continue. Above all, we are grateful for the recent infrastructure infusion from the Provincial Government.

Although Julie appears to appreciate the equipment, she does have some suggestions as to how to improve this process and appears frustrated that inservicing did not follow equipment distribution:

Over the past few years the Dept. of Ed. has spent a considerable amount of money purchasing equipment for science labs across the province. The gesture was an admirable one, however, in many cases, materials which were purchased were duplicates of what was already in the labs (eg. glassware, goggles), or was of such poor quality that it would be nonfunctional in several years. One piece of equipment which was purchased for all schools offering senior high courses was a weather station. This sounds great, as it could be integrated into several courses such as Science 1206, Science 3200, and others. However, to operate, the station has to be installed on the roof of the school. Our board has offered workshops concerning setup, operation, etc. of the station, however, I am not about to go on top of the roof of my school and install a weather station. Our school custodian, would be able to do so, if he had the time, but would need to read the installation manual and really should have been the one inserviced on installation. The Dept. would have been better off by hiring a group of individuals to go out to schools and install these properly, as mine is still sitting in the box it arrived in (over two years ago) and will be until someone else installs the equipment.

4.6 The Educational Leader's Role in Science Education

The fourth item on the questionnaire was: "What is your perceived/defined role in the delivery of science education?" Only one respondent made a distinction between the role as she perceives it as compared with her defined role. This leads the researcher to believe that the responses given by participants indicate what they see as their role, what they are trying to achieve in science education. The majority of responses indicated that educational leaders have many roles in the delivery of science education. Five main themes emerged as individuals explained their roles:

- instructional leadership,
- a focus on the learner,
- accountability,
- support teachers, and

- advocate for science.

A discussion of each theme follows.

4.6.1 Instructional Leadership

Lead teachers, department heads, principals and directors all perceive that their role in the delivery of science education is one of an instructional leader. Mary, a lead teacher, called herself a facilitator, whereas Beth, a department head, feels she acts more as a liaison. She stated “I am a science teacher and also department head, being a liaison between science teachers and admin, within the school; and also being a liaison between science teachers and district.” Ian believes his role as a principal was to oversee instruction, which is evident in his response: “I also oversee instruction so I work with the Science Department Head and science teachers regarding instructional issues/challenges.” Even though Dan also perceives that his role is to oversee instruction, his comment reveals that it is not always easy to do so. He said that his role is “to oversee curriculum in the classroom & amongst my science staff when allowed to by administrators!” Frank, who works in a directors position, specifically addressed himself as an instructional leader. He stated: “My role as a programs specialist allows me to be an instructional leader for science teachers in the district. My primary purpose is to support our teachers so that they can provide the best possible program for their students.”

Instructional leaders are not only responsible for supporting classroom instruction, they must also keep up to date with changes in science education. John not only oversees instruction but also provides support to other teachers on new curriculum: “As a department head I’m responsible for monitoring the teaching of science at my school. ...I also monitor the implementation of new curriculum and provide advice to teachers on an

ongoing basis.” In Joe’s words, his role is “to stay as current as possible in new developments to bring these into the classroom.”

Even though principals act as instructional leaders, perhaps the role of the department head affects the classroom more directly on account of the departmental meetings that take place. Teachers have the opportunity to discuss issues regarding science instruction and the department head can act as a guide and implement policies to help strengthen science instruction at a particular school. Ben described his role as an instructional leader and explained the structure that he has adapted for the initial departmental meeting in September:

As Department Head, my role is to advocate for Science resources in our school, to manage Science instruction at the school level, and to set the tone for quality Science instruction in our school. Given the recent influx of resources from the Department and having a very supportive administration at our school, the first point has never been a problem for myself, and it is a joy to work in a fully stocked high school science lab in our school. The ‘management’ of science instruction at our school involves regular meetings regarding course instruction and evaluation. The most important, by far, of all of these meetings, is the meeting we have at the beginning of the year. We look back at the previous year’s enrollments and marks (they have always been quite good, sustaining or trending upwards, with very good absolute mark values). We look at each course, and how we can best teach them as a group. In Science 1206 we ensure that every teacher uses $\frac{1}{4}$ of the school time for each unit, and we have a common vision on evaluation, particularly with Alternate Assessment projects and labs. We ensure that every teacher has the necessary materials for all core labs, and take requests for possible non-core labs. We discuss formal test evaluations, and ensure we use a Table of Specifications on all tests – using varied levels of questioning on each tests. While we do not strictly adhere to such a Table on designing a unit test, we at least understand that there must be a minimum of 10-20% critical thinking items on each test and exam in every course. This, we believe, has facilitated success for our students in Public Exams. This has also built self-esteem on students through their school years, as students have worked to find success on these items – and have seen their efforts been realized with success. We also use a Scantron machine to perform Item Analysis on tests and exams, and the results of this analysis has allowed us to identify areas of the courses where students struggle, and has allowed us to look at modifying our instruction / evaluation for these areas. With Public Exam courses, we also receive Item Analysis data from the Department of Education, which helps us do the same. In conclusion, strict adherence to core labs and a timely teaching schedule, stringent testing methods, and Item Analysis for EVERY academic course has allowed us to set a high

academic standard in Level I Science, and carry this through to Public Exam courses.

The researcher felt it was necessary to include Adam's full response to this question as well since Adam's situation is indeed unique. Recall that Adam is both a principal and a teacher in a rural school with a population of less than 25 students. His role as an instructional leader definitely goes beyond the traditional definition:

As school administrator, I feel it is my role to try and provide the best science ed. Possible to my students. This means making sure all the necessary supplies are available to teachers and students to carry out experiments. Because I do not have qualified high School Science teachers I have to provide courses to students though CDLI. Therefore I have to make sure that students understand that science can be done at a distance. Also, I have to be responsible to make sure all safety measures are in place during Labs. I also have to supervise all lab activities. I feel that as principal it is my role to see that my students receive the best education possible and that includes science and all other areas.

4.6.2 A Focus on the Learner

A second theme that was evident in the roles identified by educators was a focus on the learner. Ultimately the role of all educators is to teach students. Participants responded that they needed to keep the interest of students, deliver an enriched science curriculum and prepare students for the future. In Mary's words: "I perceive my job is to spark interest in science and to help students develop skills that they can use in their lifelong experiences." Making the "curriculum as interesting and meaningful as possible to the students" is how Juanita perceives her role and Carl is of the opinion that he needs "to prepare students for post secondary education."

In addition to making science interesting and preparing students for lifelong learning, Julie offers some suggestions as to why students may be unmotivated and presents some solutions that she has found effective:

I feel that my role in the delivery of science education is one of a guide. I think it is my responsibility to instill in my students a love of science and learning. Students often come to me saying that they find science hard, or that they don't like it. I think this is often because they've had teachers who were inexperienced

in the field of science and who were apprehensive about having to teach a subject they were unfamiliar with themselves. I've also found that students had very little experience in the lab. Over the years I've found that students love going to the lab and that these are the experiences/memories that they take with them when they leave the school setting. I think that as science teachers the best thing we can do for our students is to teach them how to learn...how to teach themselves. The best way to learn material is to have to teach it to someone else. I often have students perform practice problems on the board for their classmates...and have students explain concepts to one another. For many years I taught Biology by having students make up their own notes, which were then discussed as a class, with students adding relevant information to their own notes. However, I had complaints from students and parents that this approach required too much time on the part of the student (ie. homework). However, I found that teaching the course in this manner allowed students to process the information and thereby have a better understanding of concepts. I will say though, that students who did Biology with me in this way often approached me after leaving high school and attending university and told me that note taking was an invaluable skill which they carried with them and made their university/college education much easier. Basically I feel that our goal as teachers (all subjects) should be to prepare students to be lifelong learners, and in the case of science to develop an appreciation of the various science disciplines and nature in general.

Although Nate was unclear of what the question was asking, he too offered suggestions as to how he believes we can prepare students for independent learning:

Not clear what you are asking. Are you asking how do I think science should be taught? If so, in a hands-on fashion using problem or project based approaches. The provision of "notes" would be minimal as students would be expected to read the textbook for themselves and the teacher would help them come to understand the content through classroom discussions.

4.6.3 Accountability

Many participants responded that being accountable is part of their role as a science educator. This theme includes making sure that the specific curriculum outcomes for each course are met, as is evident from the following responses:

- "This involves checking to insure the curriculum outcomes are being taught, (and) the core lab activities are done. ... As a full time teacher, I am responsible for the courses I teach." (John, Department Head)
- "My job is to ensure that the curriculum outcomes are met, that we have adequate trained teachers" (Sam, Principal)

- “To deliver the curriculum as outlined by the dept of education” (Juanita, Department Head)
- “To deliver it as prescribe by dept of education” (Joe, Department Head)

This theme also involves being responsible for delivering a quality science education to students. Greg and Carl, who are both teaching vice-principals believe that they are accountable for planning and implementing lessons that impart science knowledge. Greg stated: “My role in the delivery of science education is to help develop the plans and activities done to deliver the lessons.” Carl feels his role is “To deliver scientific knowledge, through a variety of techniques.” As a principal Leo is not directly involved in teaching in the classroom but he is of the opinion that he can ensure the delivery of a quality science education by hiring trained teachers. He wants to “Find and keep quality science educators in the school.”

Jill also believes that she must make sure the curriculum outcomes are met and she stressed the importance of the development of science skills in her response:

In my role as a teacher, I feel I am responsible for teaching the outcomes as outlined in the curriculum along with fostering an environment where scientific attitudes are valued. For instance, a good science teacher stresses the ability to make careful observations and base inferences on those observations. Science is more than just a collection of facts but, in many cases, that is how it is taught. Unfortunately, even those science teachers who want to incorporate brain-based research, more hands on and constructivist approaches face time constraints that make it difficult to go off the beaten track. In addition, preparing for hands on activities requires a great deal of time so they often get omitted in favor of pen and paper exercises.

4.6.4 Support Teachers

The fourth theme that emerged from the data was the role of science educators in supporting teachers. It is noteworthy that all responses in this category come from administrators (four principals and one vice principal). Although not physically a member of the science classroom, administrators perceive their duty is to support the

work of teachers through the provision of resources, development of the school schedule, and search for professional development opportunities. Sam feels that his role is to ensure “resources are available. Teachers should be supported in their delivery of programs.” Greg specifically mentioned lobbying for funding on behalf of teachers: “As an administrator, I seek out new sources of funding for new equipment and new resources for our teachers.” Ian summarized a number of administrative duties that he believes supports teachers in the delivery of science education:

I am the principal so ultimately I have full responsibility for programming, scheduling, budgeting etc. ... Additionally, if there is a need in the science department, I advocate on their behalf to the District and/or Dept. of Ed. I also look for PD opportunities for my science teachers and encourage them to go. This also involves some financial support for them.

Eric stated that teachers need “materials, time, in-service, (and) support from District/Department” and that it is his job to ensure teachers “have what they need to deliver the curriculum.” Leo believes his role is to:

- “Keep existing labs and technology up to date,
- Provide necessary resources for instruction,
- Provide new materials and technology,
- Provide resources for training, (and)
- Schedule school to enable science to be taught, as many areas as possible.”

4.6.5 Advocate for Science

The final theme that was evident in the roles identified by educational leaders was to be an advocate for science. Jill is of the opinion that she needs to advocate for the needs of her department both in the school and at the district and government levels:

As a department head, I see my role as an advocate for science education in our school and to provide the district/department on the challenges and successes we experience in our school. I also believe it is essential that dept heads and classroom teachers voice our concerns.

As a principal, Ian believes it is important to promote science to the student body, to help students realize the importance of science. He stated:

In addition to the above, as an instructional leader I also promote science to students. I advise them on which courses they should pursue and I try to provide students with a sense that science is important so when opportunities arise, I try to promote science to the entire student body (we have a yearly science challenge, for example, that I promote using the intercom, our televisions, etc.).

Joe also advocates for science education by “continually promote scientific literacy both in the class and outside as well.”

4.7 How to Improve Science Education and Promote Scientific Literacy

The next question asked educators to list and elaborate on some innovative methods that they have used to improve the delivery of science education and promote scientific literacy. Again the researcher anticipated a variety of responses due to the nature of the question. Several examples of innovative methods were reported, but five main themes emerged. They are:

- using technologies;
- diverse teaching strategies and assessments;
- science activities outside the classroom;
- innovative projects and activities; and
- hands-on activities.

A discussion of each theme follows.

4.7.1 Using Technologies

The most predominant method that was reported by participants was using technologies. As described in the literature review the researcher defines technologies as devices or approaches that can be used in science education to help increase and develop scientific literacy. The specific technologies reported in the data included computer programs, a video disk player, the internet, SmartBoards, and other computer assisted

technologies. Mary uses “Corel presentations/Powerpoints with lots of pictures/illustrations” and tries to “incorporate a variety so that the idea of diverse learners is addressed.” Julie continues to use a video disk player, which is an older piece of technology but is still an invaluable tool in her classroom. Julie added, however, that she would like use more modern technology but struggles with the availability of computers in her school. She commented:

One piece of equipment which I found quite valuable in the past (and still use today) is the video disk player which gives students a chance to watch a short video clip and to see images of organisms, etc. that they have never seen before. ... Personally, I would like to do more with the Internet and computers, however my computer/technology skills are lacking and I often find that the computer room is not up to par and that a period in the computer room is too frustrating for both me and my students. As well, many of these above activities require TIME!!!!

Other teachers have realized the potential of the internet as a learning tool. John uses the internet in a variety of ways, as was evident from his response:

The internet is a great source of material to enhance the delivery of science education and promote scientific literacy. Whether it is accessing on-line video, using virtual labs or tapping into real time news coverage of scientific issues, the internet is a valuable resource provided you take the time to sort through all that is available on the internet.

Carl also uses the internet for simulations and virtual labs called EduLabs that are available through CDLI, the Center for Distance Learning and Innovation.

Not only will using technologies appeal to a variety of learners, but it will also help students to learn science in different ways. Nate commented on his past experience in the classroom: “I have utilized technology to try to improve their experience or to help them “do the science” differently.”

A relatively new piece of technology in the science classroom is the Smartboard. Participants are introducing this interactive whiteboard in their science classes in order to improve the delivery of science education and promote scientific literacy:

- “We have two smartboards and our Science teachers use this technology to bring greater meaning to their instruction.” (Ian, Principal)
- “SmartBoards (are) used by teachers on a daily basis to bring multimedia teaching to classes.” (Ben, Department Head)
- “Increasing the use of SMART board and other computer assisted technologies.” (Eric, Principal)
- “we have purchased a smartboard that is used for all classes including science classes.” (Greg, Vice-principal)

In addition to using a Smartboard, Greg has also made an effort to use technology for lab activities: “our lab has been retooled and stocked this past year. We have purchased new multimeters, and a adapter for a microscope to be connected to a computer.”

Although it is certainly beneficial to incorporate new technologies such as the Smartboard in the science classroom, not all schools have the funding to provide teachers with this resource. The research believes it is equally important to be adaptable, to be able to use the technologies that are available to improve instruction. Juanita, for example, described how she uses a projector in her classroom:

I now use a laptop + projector to deliver my classes most times. This allows me to project animations, diagrams, look things of interest up on the internet – all with the students watching the whole thing. I also can now give them internet addresses for relevant quizzes, animations, problem sets etc

4.7.2 Diverse Teaching Strategies and Assessments

A second theme that emerged from the responses to question five was the use of diverse teaching strategies and assessments. Dan continuously adapts his teaching style based on the students in his classroom. He stated that he uses: “Diverse teaching methods.” He continued by saying: “My instruction follows no set pattern. It evolves with the type of students I teach and the situation at the time. I engage in continual self

reflection.” As a principal, Eric has tried to create a Professional Learning Community within his school to improve science education. He claimed: “We are moving forward with the PLC concept. This will have a positive effect on deliver of all curriculum.”

Another example of a diverse teaching strategy used by participants is to relate learning to current events. In Nate’s words:

I have tried to relate the things they are learning in the classroom to real world events and processes so they could see why it mattered and why it was important to them. Where possible I have helped them to make the STSE links. I have tried to get them to think like scientists, to put themselves in the shoes of the person who has made a series of observations they have made or that others have made. I have tried to emphasize the nature of science and to help them dispel the myths that are perpetrated by the media and sometimes ourselves and our textbooks.

According to Nate, if we make science education relevant to students they will be motivated to learn. Julie also links current events to her classroom teaching, but has experienced frustration in the past with inadequate technical support to be able to participate in such events. She explained that:

Each year I do one new thing in one or more of my courses. I usually try to link these to current issues or to science celebrations such as National Science and Technology Week, National Wildlife Week, etc. I will often have students do a research project which is linked to the current theme. However, many schools would be limited in their participation of some activities. For example, one year our school registered to take part in National Science and Technology Week. I registered our school and we received a party pack which included posters, prizes, etc. Kids took part in on-line activities and were very excited about a real time discussion we would take part in which involved several scientists to whom they could pose questions. However, when we tried to connect we could not participate because our school could not access adequate bandwidth for downloading the video.

Participants have also introduced diverse assessments in their classroom to improve learning. Jill listed a number of techniques that she has tried in order to help students increase their understanding of science. She reported that:

As much as possible I try to use the students’ previous knowledge as a jumping off point for learning. I have used formative assessment techniques such as rubrics, foldables and alternate assessments in my courses. I try to use pragmatic constructivism – an approach that sees students constructing their own knowledge

whenever possible. At the same time, this pragmatic constructivist approach recognizes that students cannot construct all scientific knowledge on their own. I also like to use projects, cooperative learning (students become experts and then share their expertise with the rest of the class).

Carl uses previous public exams to prepare students and gives “assignments on topics such as cloning, stem cells, etc.” Juanita has found success with self-testing. She gives “pretests where students can judge how they’re doing before they write the actual test.” In her words: “This enables them to study what they don’t know before assessment. Marks are increasing because of this. Note: pretests are all multiple choice because of time factor.” Juanita also uses what she called text reading sheets. She stated:

These are multiple choice questions based on the assigned text readings. Students must read the text, fill in a scantron card on what they read, and they get a homework grade. Although this sounds redundant, we were finding that students never did their assigned readings before we put this in place. Now they do and marks are improving.

The strategies and assessments that teachers use cannot reach their full potential unless shared amongst colleagues. Another practice that helps the delivery of science education and improve scientific literacy is to learn from each other as stated by Beth: “We, as science teachers, realize that we have a lot to learn from each other, and our learning is thematic of our science meetings.”

4.7.3 Science Activities Outside the Classroom

Participants also identify science activities outside the classroom as an innovative way to improve science education. Students can develop a greater appreciation for science by participating in science fairs, science competitions and science excursions throughout the community and province. Nate stated: “I have established science clubs and engaged students in both science fairs and science “Olympic” activities.” Beth and Joe have also participated in science fairs and science competitions. In addition to these activities, Julie has also brought her students on field trips. She wrote:

In the past I have organized school science fairs, which sparked interest among students, especially those who attended the regional science fairs and came back to spread the word about their experiences. Other activities included science Olympics, science days, and career fairs which focused on science and health related careers. ... For many years our school went to Terra Nova National Park to do the boating/shoreline trip offered in Newman Sound through Ocean Watch Tours. I've also organized trips to parks such as the Thomas Howe Demonstration Forest outside of Gander, the tree nursery in Wooddale, the pulp and paper mill in Grand Falls-Winsor.

Another activity outside the classroom that empowers students to taking learning into their own hands was reported by Beth:

We have an environmental group made up of students who are interested in diverse aspects of the environment – in this group, through their various activities, students realize and get to experience that their 'voice' is important and can make a difference. This group reaches out to the entire school community – it's all about science and the citizen and how individual actions can affect the world.

In Ben's school, students have the opportunity to be involved in various co-curricular activities such as "participation in MedQuest, WISE, Discovery Days in Health Science (MUN Med School), Cardboard Boat Race (champions), Brother Brennan Centre (first high school to take a Science 1206 group)" and Ben is proud of his school accomplishments. At Ian's school they have implemented a science challenge within their intramural activities. His comments were: "We incorporate science into our intramural system. We have a horsepower challenge that builds on concepts learned in physics. Again, this is open to all students."

As principals, Ian and Leo also support science activities outside the classroom from an administrative point of view. Leo's school is "Involved in a number of projects, TILE, STEMNET, APEF, National Inst. PM Awards to help enhance science and technology in schools." Ian promotes the science challenge in his school and reported that academic students travel to post secondary institutions to learn from lab technicians. He stated that:

We have a yearly science challenge that is open to all students. We have prizes and promote it to the entire student body. ...All of our academic science students get the opportunity to travel to CONA in Burin and work with their Lab technicians at least once a year.

4.7.4 Innovative Projects and Activities

Although somewhat related to the last theme, a fourth theme that emerged from the data was the use of innovative projects and activities. The research chose to separate this idea from the last one since the projects and activities that correspond with this theme are performed in the classroom setting and include journal writing, using guest speakers, introducing science articles in the classroom, performing innovative labs, and the use of popular media.

Both Mary and Julie have used journals to help students to develop their science knowledge. Mary provides an “opportunity for personal reflection and journal writing which allows students the chance to develop their own perceptions.” Julie bases the student journal writing on science articles. She stated “students keep a journal in which they would read any science related article and write a short summary on a regular basis.”

Ironically, Beth stated that she does not do anything innovative, but then listed a variety of projects and activities that improve the delivery of science education in her classroom. Part of her response to the question was:

Nothing innovative, I'm sure...however, encouraging and inviting speakers from the science world to the school. ... We avail of the local newspaper on a daily basis—students search out ‘science’ articles, and are quite surprised, at times, to see articles on what we have just been discussing in science. ... Cross-curricular involvement in science projects, the students in one grade level are working on research papers on various aspects of science in the curriculum, and both the English and Science teachers have developed a rubric and will both grade the assignments.

Jill also finds the use of projects effective. She uses a cooperative learning strategy whereby “students become experts and then share their expertise with the rest of the class.”

Other innovative projects and activities that appeal to students interests are “using music, visuals” (Joe), popular media and innovative labs. Nate stated: “I have made use of popular media by bring television content, magazine articles, science fiction, etc, into the classroom for them to consider in light of what they are learning.” In doing so Nate made learning relevant to his students. Ben chose to use various lab innovations to help improve science education and improve scientific literacy. He listed them as follows:

- modifying / adapting core labs to improve them;
- adding to the core labs by writing / finding excellent labs; and
- looking to invest in Vernier digital data collection.

4.7.5 Hands-On Activities

The final theme of using hands-on activities was quoted as the most innovative method by Henry. He claimed: “The most innovative way is actually old school. We do science as opposed to lecture on science. The more we do the more we promote.” When students perform hands-on activities learning is reinforced. Mary and Carl also use hands on activities. Mary stated:

Incorporate many laboratory experiments to provide hands-on activities. This reinforces topics discussed and provides time for exploration. During experiments, I often get students to complete experiments which give unexpected results. I explain to students that the important thing is to realize that something was different and to propose reasons why.

Not only do such activities reinforce learning, but they also spark interest in students according to John: “Organizing additional lab activities keeps the students interested and provides an opportunity to increase the depth of treatment for key topics.” Julie offers enrichment labs afterschool that were once part of the curriculum. She stated: “I usually offer dissection classes (frog) to students after school, as this skill is no longer a part of the regular curriculum.” It is obvious that Julie believes such hands-on lab skills are valuable.

4.8 Science Education and the Changing Workforce

For the sixth question, participants had to list some suggestions as to how the delivery of science education could be improved to better meet the changing needs of our workforce. Four themes emerged from participant responses including:

- changes to curriculum,
- focus on the learner,
- provide training for teachers, and
- link the classroom with the workforce.

A discussion of each theme follows.

4.8.1 Changes to Curriculum

There were two main suggestions that fell under this theme, namely reducing the number of specific curriculum outcomes and making the curriculum more relevant to students. Although Carl stated he does not have a problem with the way curriculum is delivered he did state there is “just too much to deliver in the amount of time to deliver it.” Several participants are of the opinion that the curriculum is jam packed. In John’s words: “The high school curriculum needs a tune up in order to decrease the number of curriculum outcomes in most courses. At present, the curriculum is too full.” Jill suggested cutting out “20% of the content” which would permit teachers to spend more time on topics according to Edna who said: “Less material to cover so that more time can be spent.” By reducing the content teachers would have more time to help students develop a deeper understanding of science concepts. With too many curriculum outcomes teachers felt that they did not have enough time to give the material adequate attention. Ian also made suggestions to reduce the number of outcomes as well as “move Science 1206 to Grade 9” which would make more room in the high school program.

The second suggestion made by participants was to make the curriculum more relevant to students' lives. Beth believes that "The science program for non-academic students, should be more *applied!*" in order to address the needs of these learners. Sam added that a cross-curricular approach would help students make connections between their courses. He stated:

I believe that a cross-curricular approach would be beneficial. Curriculum outcomes can be met in many ways not only through a chosen course. Why not explain how scientific events affected historical events or use scientific examples in Math? Students need to see relevance in their studies.

Not only should students make connections between courses, but they should also realize that their actions today can and will affect the future. The curriculum should be "more relevant to real life situations" (Juanita) so that students can make these connections.

Greg made a valid point about our impact on the environment in particular:

"Environmental issues need to be more current and relevant to the students. Global warming is here and students need to be shown how they have affected the planet and how to reduce this effect." If students are aware of how the ignorance of mankind has impacted their lives they will be more inclined to think critically before they act.

Other participants made suggestions as to how to change the curriculum. Joe recommended to "make the curriculum in each more focused and less broad" and to "have all relevant stakeholders have input in curriculum development." Julie made specific recommendations as to what should be included in the curriculum in Newfoundland and Labrador to make it more relevant to our students:

As I mentioned earlier, the curriculum is often not relevant to our province. Perhaps the Dept. of Ed. could put together some current videos highlighting some of the current scientific/technological advances in our province (Voisey's Bay, Churchill Falls, research at the Marine Institute, the School of Medicine, etc.) which could be distributed to schools. Even teachers cannot keep abreast of all the current developments (again time is a factor....I should be a deliverer of curriculum...not a developer). Also, much of the science curriculum is geared to the small percentage of students who will attend university (chemistry, physics,

biology). Most of the student population will either enter a trade or work in a job such as the service industry or sales. The recent addition of Science 2200/3200 is geared to the “basic” student, yet really it is only a watered down version of Science 1206. These students will never need to use the information which they are being forced to learn (eg. balancing chemical equations) and most of them are intimidated by science. The courses such as STS 2206 which have been removed from the curriculum were more relevant to these students, who could relate to the information they were learning (forestry, fishery, reproductive technologies, etc). Another area which is sorely lacking is that of the Earth sciences. I’ve been teaching in the same school for 19 years and I can’t remember the last time an Earth science course was even offered. This is partly due to declining student enrolment, but also to teacher education. As the lead science teacher I have no training in geology/earth science, as my background lies in biology and chemistry. There has not been anyone who was able to teach an earth science course, and there would have been very few students interested in this field. Also for years, MUN entrance requirements included the “lab sciences” and not geology. With all the oil and mineral exploration currently taking place in our province (not to mention western Canada) this is an area which needs to be addressed.

Julie believes that in order to make curriculum relevant to her students, it is up to her to make the connections with current developments in the province. And although this is possible for some courses, she is concerned that the basic science courses do not match the needs of this type of learner, as was already mentioned by Beth. Finally Julie made a valid point in revealing that despite our province’s success with the oil and gas industry, our curriculum does not prepare students for a future in this growing field.

4.8.2 Focus on the Learner

A second theme that emerged from suggestions was the need to focus on the learner. In order for teachers to focus on improving science education they need to focus on the needs of the learner. Mary feels that “encouraging students to explore and question will prepare them to look for personal ways to improve when they enter the workforce.”

Many jobs will have tasks that are specific and will be learned on the job, yet science educators can better prepare students for the world of work through skills development.

Jill made the following suggestions:

- “Focus on skills and understanding rather than content. I.e. decrease the ‘facts’ students need to know and emphasize a scientific approach to problem solving.”
- “Get students working in small groups and teams....this skill is valued in the workforce”
- “Allow science teachers more autonomy – stop the emphasis on standardized testing and ‘sameness’. If a teacher has expertise in geophysics, they should be able to provide enrichment to their students. Currently, it is difficult to do this.”

As is evident from Jill’s final comment she believes that there is little room for teachers to focus on developing skills in different areas due to the pressure of standardized testing from the Department of Education. Henry is also frustrated that he does not have enough time to develop lab skills due to the amount of content. His comments were: “More doing, this is widely known as the best route. The department, however, opts for more content and wants science to become only Social Studies or only Math and not real Science.”

A final recommendation made by participants that would help teachers focus on the needs of students was to have “class size caps for science” (Leo). It is difficult to perform labs and other hands on activities with a large number of students. John stated that “Class size needs to be capped to insure science classes are small enough for the lab space available in schools.”

4.8.3 Provide Training for Teachers

The third theme of providing training for teachers also consists of two component parts. Firstly, participants are of the opinion that we need “better qualified and trained teachers” (Joe) which implies that this training should occur in pre-service teachers. Dan commented that the science training of primary/elementary teachers is inadequate. His recommendations are to: “hire qualified science teachers, train (realistically) teachers at

the elementary level in science, revamp the primary/elementary program at MUN to directly reflect what is needed now, not 30 years ago.” If students have teachers who are not qualified to teach science education at the primary and elementary levels then they are likely to enter high school science lacking the foundation knowledge needed to further develop their science skills.

The second component of this theme is the need for professional development and inservice training for science teachers. If teachers want to prepare students for the world of work, then they too must keep up to date on both recent teaching methods and available technologies. Ian asked for “more PD for Science teachers” and Leo saw the need for “continued training for teachers with resources to attend.” Leo’s comment shows that in order for training to occur, the government must be willing to provide the appropriate resources (time and money) to make it happen. Eric believes it is important to learn from other science teachers and experts in the field but also wants the assurance that time will be allocated to allow this interaction to take place. His suggestions were:

More frequent, meaningful contact with their peers and experts in the field.
Collaboration with experts in the field in developing lesson plans that can be meaningful when delivered in less than ideal conditions.
Guaranteed TIME in the regular day to prepare/collaborate

Nate is of the opinion that it is not only important for teachers to have the opportunity to interact with others in their field, but also to keep up to date on current events and teaching practices. He suggested that science education could better meet the needs of the workforce through:

- Regular PD opportunities to help teachers keep up with current events in their subject area (to help them “add color” and relevance to the content they are teaching.
- Long term, continuing PD on different instructional practices to help teachers become more comfortable with trying different approaches.
- Regular opportunity for teachers to meet and share what they are doing different in their classrooms and which is getting results.

Although Frank did not specifically state teacher training or professional development in his response, he alluded to teacher training by stating that “assessment for learning strategies” and “developing teaching strategies that meet the needs of all students” would improve the delivery of science education. Frank would also like to see a “stronger focus on performance assessment.”

4.8.4 Link Classroom with the Workforce

A final theme that emerged from the responses to question six was linking the classroom with the workforce. In order for science teachers to prepare students for employment in the competitive job market they need to emphasize how important science education is for finding meaning work. In Jill’s words, teachers need to

Emphasize where science is needed in the workforce. Too many students think that a career in science involves a lonely life in a lab coat and safety glasses – there are many other areas where an understanding of science is valued.

One area that was specifically mentioned by participants was the skilled trades. The Department of Education has recently introduced courses in the skilled trades, but Ian believes that teachers need to “link science with the skilled trades.” Adam also pointed out that these courses are not available to all students. He stated he would like to see “more skill trades opportunities for all high school students.” Not all schools have the facilities yet to offer such courses and not all students can fit these courses into their program due to graduation requirements or scheduling conflicts.

All students have to take a career education course to graduate, but this course does not focus on other curriculum areas according to Beth:

The new career education course needs to have a more cross-curricular approach!! The new science textbooks do include a profile of scientists and their careers, but the career course and science courses should work together – to invite speakers, discuss careers.....HOWEVER...the question, of course iswhere does the TIME come from!!??

By using a cross-curricular approach, students would be made aware of what careers link to the subjects they take on a daily basis, which would in turn prepare them for course selection in high school and post-secondary. Beth's frustration with time is obvious. She made a final suggestion that job shadowing would be beneficial but again was concerned with where the time would come from. Through job shadowing students get a better idea of what actually happens in the world of work rather than reading in a textbook. Julie is also of the opinion that schools should be doing more to collaborate with business and trades people so that students can get more exposure to the specific careers that are available. Although her school participates in a career fair, she did not feel that this was a successful venture due to lack of follow-up support. Her comments were:

I also feel that there needs to be more collaboration between businesses/trades and the schools. Thus students can be made aware of the opportunities which await them when they graduate and which careers require specific skills/ educational backgrounds. Every two years students attend a career fair in Gander, however, many students do not bother to attend and see it as a day off, so they miss out on the information. Those that do attend often get some of the information which they need regarding educational requirements, etc. However, when they return to the school there is little follow up. Unfortunately, in many schools there is limited access to guidance services. For example the guidance counselor in our school is shared between three schools. Much of her time is taken up with formal testing or dealing with discipline/social issues leaving little time for career counseling.

4.9 Science Education in Newfoundland and Labrador

The final question asked participants if they would like to make any additional comments regarding science education in Newfoundland and Labrador. A number of participants used this opportunity to discuss certain frustrations they have about science education while others chose to mention positive experiences they have had with certain aspects of their job. Some respondents left this space blank. Although four main themes emerged, some comments were not relevant to the study or simply did not fit into a specific category. Specific references will be made to one such response at the end of

this section since the researcher felt it was important to allow the participant's voice to be heard. The four themes that will be discussed now include:

- positive feedback;
- teacher training is needed;
- curriculum improvements are needed; and
- challenges of teaching in rural communities.

4.9.1 Positive Feedback

Participant responses indicated that improvements are being made in the delivery of science education. Mary stated: "I think that science education in Newfoundland and Labrador has improved in the past few years. Reviewing and changing curriculum helps the province stay on top of advancements made in science." If curriculum developers continue to try to enhance the specific curriculum outcomes then students will have an up to date knowledge of advances in science and technology and will be better prepared for jobs in this field. Frank also agreed that science education has improved in recent years. In his words:

Science education in our province has improved tremendously over the last few years in my opinion. The emphasis on hands-on learning with a focus on all learners is improving science education and will continue to improve it if these strategies remain a focus.

Other positive feedback mentions local curriculum connections, hands-on core labs, teacher training and online support for teachers:

- "This province has a history of strong science education. More junior high schools have science – trained teachers (but, not all). With the new, more rigorous JH courses – this must be the case. ...Conference and forums on district FirstClass is very helpful" (Beth)

- “I like how they are incorporating more of Newfoundland in some coursesI like the core labs and the fact that student’s are given more hands on.” (Edna)

These educators believe that strides are being taken in the right direction to ensure a quality science education for our young people. Finally, Juanita thinks that our science program is competitive when compared to those of other provinces. She stated: “I think it’s probably one of the best systems in Canada.”

4.9.2 Teacher Training Is Needed

The remaining themes identified by the researcher include suggestions for ways to improve the delivery of science education. Some participants are of the opinion that teachers need more training to help them with specific areas of curriculum delivery. Carl feels that there is “not enough trained science teachers” and that ‘teachers with “minors” are expected to teach many different sciences in schools’ even though they do not have the same background as those teachers with a major in science. Julie believes that training is needed for science teachers outside of their own specialty area. Her comments were:

... since very few schools in our province allow for a science teacher to teach just one science, such as chemistry, perhaps our teacher training should be adjusted to reflect this. I wish I had more physics and earth science background. Then I would be more comfortable in these subject areas. I would also like to see more training/upgrading available to teachers in the form of workshops, or perhaps even on-line courses. I am aware of only one such offering in our province at this time which takes place in Gros Morne during the summer holidays. However, I have taken part in both SEEDS and KEY Foundation programs in western and central Canada.

Beth stated that “Teachers of all levels, should be aware of the courses that come before and come after their own courses.” This implies that if teachers are aware of what is specifically taught in other courses they can better prepare for their own courses and make links between courses, which would strengthen students understanding.

Teacher training also includes the specific professional development needs of a particular teacher. Jill revealed that science teachers in rural areas have unique needs and should be provided with the appropriate guidance:

The other issues is the lack of guidance for teachers delivering the science curriculum in a multiage environment. At the very least, the dept should provide schools with some suggested linkages or 'order of teaching' so that these schools can deliver the curriculum.

The Department of Education has tried to assist science teachers with the provision of new equipment, but professional development is still needed so that teachers know how to appropriate use these instruments in the classroom. Adam stated:

We need more training on how to deliver the best science ed. possible to all of our students. Over the past few years gov. has provided schools with a lot of science equipment. Now it is time to provide the teachers and training in how to use it. I have a lot of science equipment still in boxes because no one knows how to use it. Let's get it out and train the teacher so he/she can provide a better science ed. to the students.

4.9.3 Curriculum Improvements Needed

A third theme that was evident in the data was the need for improvements in curriculum. As was mentioned in previous sections there is too much material to cover. Joe used a phrase that is commonly used to express that the curriculum is overloaded: "There is a major need to improve the curriculum which is often quotes as being a mile long but only an inch deep." Carl believes that Science 1206 prevents students from taking other courses and although he would like to see it removed, he feels there is nothing he can do about it. In his words:

Science 1206 has caused many Nfld students (rural schools) not to be able to get both levels of the academic science and therefore it is my belief that it has not accomplished what it was set out to do BUT its here to stay

Other participants called for a revamping of the content, requesting that it be relevant to current issues and linked locally.

Overall, I feel we could improve science education for the average student by generalizing more, producing content which is more relevant to our province and reducing the material in some of the courses, so that teachers are able to explore other areas/topics with their students. Also, many courses remain in effect for over 10 years, during which time much of the content becomes outdated. I realize there is a cost factor involved with changing course content more frequently, not to mention additional work for teachers, however science and technology are two rapidly evolving fields of study. (Julie)

However, we need to look more at what students will *use*, in a real life sense and less at what universities want us to do to prepare students. I'm teaching material in grade 12 that I completed in 3rd year biology. That's fine, but does every Newfoundlander need/want to know how DNA replicates? Probably not. How they inherit genetic disorders? Probably. We should be concentrating on the students' potential needs – not post-secondary institutions desires. (Juanita)

4.9.4 Challenges of Teaching in Rural Communities

Newfoundland and Labrador has a unique education system largely due to our geography. The majority of our schools are found in rural and remote regions and therefore carry with them a unique set of challenges in trying to deliver a variety of courses. Simply stated low teacher allocations translate to fewer courses being offered. Students will either have to take courses via distance or not have the opportunity to take the course at all. Julie vented her frustration with the workload she assumes as a result of teaching in a small school and trying to deliver as many courses as possible:

I'd also like to make a point about distance education courses offered to small schools. In our school over recent years we have not had enough students to offer Chemistry 3202 and now Chemistry 2202. As the lead science teacher in our school it has been put upon my shoulders to carry out all lab work associated with these courses. This is on top of my regular workload. In the past I was doing these labs after school and during lunch hours. However, last year I put my foot down and now I get to do them during my preps!!!! This is hardly fair! If lab courses are to be offered in small schools then something needs to be worked out in terms of supervising and helping these students. Not only that, I have some chemistry background and feel comfortable doing these labs, but what about a teacher in a small school who has little or no chemistry backgroundwhat do they do?

Many schools face the challenges mentioned by Julie since there are not enough teachers to offer a full course load. Julie actually made a suggestion as to how the Department of

Education could help with this situation: "I think we need to recognize that over 50% of our schools are in rural communities where it is difficult to deliver the high school program. An acknowledgement of this might include flexibility in the high school graduation requirements." Jill agrees that the workload for rural teachers is more due to the amount of courses they are responsible for. She suggested that a different student teacher allocation be used to address this challenge. Her comments were:

I also believe that it is irresponsible to use the same allocation for rural schools as is used to staff urban schools. The argument runs something like this "You might have 15 courses to teach but I have class sizes of 35". Well, I've taught in both situations and I can state with a great amount of confidence that large class sizes don't even come close to the same workload as having a big pile of courses to prep for.

4.9.5 Other Frustrations

In previous sections participants stated science fairs as a way to improve the delivery of science education and promote scientific literacy in Newfoundland and Labrador. When asked to make any addition comments in the final item on the questionnaire, Ben felt it was important to express his opinion on science fairs. He believes that science fairs promote misconceptions in science and in fact deter students from taking science courses. The researcher felt it was important to share a portion of Ben's comments since his thoughts provide another perspective on the use of science fairs to promote scientific literacy:

I truly believe that Science Fairs are the source of some of the most common misconceptions regarding "science literacy" and the study of science in general. Consider: The model of the classic yet current science fair project is commonly: "Introduction/Purpose/Theory-Materials-Procedure-Analysis-Conclusions." Nothing could be further from the truth in terms of the modern study of research science... the best scientists today never blind themselves with linear thought; they must be thinking "outside the box" if they are truly going to make a difference in their research. Also, to hinge success on a distinct conclusion is not only dangerous to the morale of the science student who had an excellent idea for a project which did not "pan out"; it also is simply not the expected result of much of the best research... The number of meaningful research ideas which can be

summarized in a nutshell on a Quartet-brand presentation board are few and far between in the real science world; why do we mislead our science students in thinking that science fair science is the way real science is done?... In a lot of cases, the studies are not even science experiments, yet instead are consumer tests, social studies projects or simply models of (not experimental) science ideas... Nowadays, with the Internet, ideas are quickly found from a Google search, and someone's work from halfway around the world is essentially copied. In many cases, it is Science Fraud in the true sense of the word; a copy of an experiment found on the internet is done, copied right down to the results. If we continue to push science fairs on our students, we are simply giving students an opportunity to practice academic fraud. This is not real science. Science fairs have a tendency, if the truth is to be known, to turn students off from science, instead of turning them on to science. Students are often forced into these science projects by their curricula or science course evaluations, and in an attempt to "get it done", little or no thought is actually given to the "science" intent of the project. Every year I poll my students, asking if they would like to do a science fair, if given the opportunity, as it can be "easy marks." Even with the carrot of "easy marks" dangled in front of them, less than 3% of the students are interested – their previous experience with mandatory science fairs have not motivated them to do more such science – it has de-motivated them! In conclusion: We would do a lot as Science Educators to have a second sober look at the 1950s model of science fairs which really have not changed today. We should ask ourselves if we are doing students a service – or more importantly so – are we doing our students a disservice by continuing with these archaic science fairs while trying to foster modern science thought and modern science education.

4.10 Summary

The researcher has presented a variety of themes that arose for each item on the questionnaire and used salient quotes to reveal participants point of view. As is evident from the headings, some questions shared common themes. Such themes are identified as predominant categories by the researcher since they were present in more than one instance. Table 4.1 below illustrates the predominant categories that surfaced across responses and key concepts are given for each.

Figure 4.1 Predominant Categories and Key Concepts – The predominant categories that emerged from participant responses to all items on the questionnaire.

Predominant Categories	Science Skills and Knowledge	Curriculum	Technology	Focus on the Learner	Teacher Training
Key Concepts	Helps students understand the world	Too broad	Important to life	Is the role of educators	Impacts student learning
	Helps students prepare for their future	Should be relevant to students lives	Appeals to diverse needs of learners	Students have poor work ethic	Training needed for new equipment
	Being able to perform experiments	Insufficient links to local interests	Issues with unequal access and funding	Make curriculum interesting	Not enough trained science teachers
	Being able to analyze and evaluate	Too much content results in fast pace	Technological devices help develop scientific literacy	Large class sizes impede	Professional development needed to keep teachers up to date
	Fosters lifelong learning and inquiry	Students need more exposure to science	Without science we would not have advances in technology	Need to prepare students for their future	Rural teachers need training for large course load and multiage
	Understanding science concepts and applications	Reducing content promotes deeper understanding	Need a background in science to keep up with modern technology	Prepare students for lifelong learning	
	Making informed decisions based on science knowledge	Change credit system to allow students to take more science courses		Modern classrooms contain varied abilities	
	Involves critical thinking, problem solving, independent learning			Challenges of rural education (multiage, course availability, etc.)	

CHAPTER 5

Findings and Discussion

5.1 Introduction

The main purpose of this study was to examine educational leaders' perspectives of high school science education in Newfoundland and Labrador. Specifically, it was anticipated that the study would help to define scientific literacy and the role of educational leaders in the delivery of high school science education according to participants, in addition to providing suggestions on how to increase scientific literacy and prepare students for future employment.

The study was guided by a general research question and six subsidiary research questions as outlined in Chapter 1. Chapter 4 presented and described the themes and predominant categories that emerged from participant responses. This chapter will discuss the particular findings of the study with reference to the literature using the subsidiary research questions as a guide.

5.2 Research Questions

How do principals, science department heads, and lead teachers view science education?

Without exception, all participants feel that science education is important. They provided a variety of reasons including:

- Science education helps students develop skills, such as critical thinking, decision making, independent learning and problem solving, that they will use throughout life.
- Science education has impacted society in positive and negative ways. Students need to have a science background to develop new technologies but they also

need to be aware of the problems that face our planet and help to provide solutions to science issues.

- It creates scientifically literate citizens who are informed about science and capable of making appropriate decisions based on their knowledge.
- Science education provides has provided us with technological advances.
- Science education is important in preparing our students for furthering their education and finding meaningful employment.

Some of these elements are also present in the literature. Blades (2003) stresses that individuals must be scientifically literate to debate and discuss issues in society. Hurd (1958) acknowledges that science education influences the well-being of society as well as social progress. Roscoe and Mrazek (2005) comment that science education used to solely focus on preparing students for science related programs. Now science education, with the goal of scientific literacy, must also prepare citizens to live fulfilling and responsible lives, contribute to the nation's economy, and participate fully in a democratic society as informed decision-makers" (p. 13).

Although the literature states that having a scientifically literate population benefits the economy, there appears to be a gap in the literature as to why science education is important. Participants stated a number of reasons why science education is beneficial to students, their development, their lives and their future, yet the literature on science education focuses on particular disciplines and fails to provide justification for the importance of science education itself.

According to the *Foundations for the Atlantic Canada Science Curriculum* which is the foundation for science curriculum in Newfoundland and Labrador, scientific literacy is the vision for science education and science curriculum needs to identify the knowledge, skills and attitudes necessary to foster scientific literacy; present the current

view of the nature of science; and describe an instructional environment where learning occurs (Atlantic Provinces, 1997). Development of skills and scientific literacy both emerged as themes from participant responses, although our curriculum does not specifically focus on science education as being important in realizing its impact on society, advancing technology, or providing a future path for education and employment, even though participants feel these are all reasons why science education is important.

What does scientific literacy mean to educational leaders in Newfoundland and Labrador?

When asked to define scientific literacy, participants provided a variety of responses, all of which agreed with the literature on scientific literacy. Pella et al. (1966) proposed that scientific literacy is understanding the relationships between science and society, the methods of science, and science concepts. The predominant theme in participant responses was that of knowledge and understanding. Participants believe that scientific literacy means having a background knowledge in the sciences and being able to understand science concepts and their applications based on this knowledge. Although not mentioned by Pella et al. science skills has been added in a more recent understanding of the term and is included as the second theme in participant responses. Kemp (2000) notes that the Standards include Science Skills and Science and Mathematics as key elements of scientific literacy. Nate mentioned the importance of understanding the different disciplines of science, that is having “a general understanding of general science concepts in the various subdivisions of science” but not one participant singled out the connection between scientific literacy and Mathematics. Rather they focused on the skills of critical thinking, decision making, analyzing and evaluating in addition to scientific processes carried out in a lab. It is also noteworthy that lab processes was not

specifically mentioned in the literature, although Cavanagh (2008) does allude to the process of data gathering when he defines scientific literacy. He claims that making informed decisions based on evidence is part of being a scientifically literate individual. In order for someone to gather evidence they must understand processes and procedures in a lab situation.

Another common element between the literature and participants responses is the inclusion of science communication in the definition of scientific literacy. The researcher titled the third theme Literacy and Communication to distinguish between being able to read, write, understand and communication science, which were all themes retrieved from participant responses. For example, Julie perceives scientific literacy means “being able to read, understand and learn about science and technology” and Frank defined scientific literacy as “the ability to communicate effectively about the world around us.” Science communication is one element that Pella et al. (1996) reported in their review of the literature on this topic. More recently Hodson (2008) state that scientific literacy means being able to read and understand articles in addition to making informed, environmentally responsible and socially just decisions.

A final theme that was evident in both the literature and participant responses was how science applies to society and everyday life. Several authors have mentioned the importance of science in society and emphasized the link between the two (Hurd, 1958, Pella et al., 1966, Blades, 2003, Roscoe & Mrazek, 2005, and Cavanagh, 2008). Participants stated that scientific literacy means “understanding the role of science in our life” (Leo), having “a great knowledge of science concepts and be able to apply this knowledge in real life situations” (Adam), and being able to “use principles grounded in the sciences to help explain” the world (Eric). Even though participants acknowledged that society depends on science, they did not specifically mention the responsibility we

have to ensure the sustainability of our planet. According to the literature, the concept of scientific literacy is shifting away from a purely science perspective to a systems view of the world, yet participant responses focuses on science related issues for the most part.

What are the major issues facing science educators in Newfoundland and Labrador?

Six themes emerged from responses to this question, some of which were present in the literature regarding issues in science education and some were not. Participants are of the opinion that the major issue affecting the delivery of science education is curriculum content; the curriculum is too broad, contains too much material and does not appeal to the interests of students. John feels that “science curriculum is jam packed with material, most of which is given a cursory treatment” and Sam agreed stating that we “need a current and adaptable curriculum.” Jenkins (2003) also feels that science curriculum heavy laden with facts, out of date and value laden. He comments that “although science education is concerned with introducing students to the rudiments of the most authoritative and reliable knowledge that we have about the material world, school science courses are conceptually and methodologically inadequate to realize this goal” (p. 274). Although participants are calling out for curriculum reform, Jenkins (2003) cautions schools against attempting to hermeneuticize the curriculum since “scientific knowledge is essentially instrumental, concerned with prediction and control, and has no place for ethical categories” (p. 274).

Another issue that is stated in the literature that links with participant responses is a focus on the learner. Hodson (2008) claims that educators will have difficulty achieving scientific literacy due to the social and/or economic status of the learner. He commented that females and minority groups also have more difficulty with science. Finally, low academic performance perpetuates by de-motivating the learner.

Participants recognized that learners have a diverse set of needs and trying to adapt classroom practices to help all students achieve is a challenge. There is a lack of ethnic diversity in our province, so this topic was not evident in participant responses. Unique to our province, however, is the needs of rural schools and rural communities where it is a challenge to offer a full programs. The literature does not comment on the challenges of delivering an enriched science program in rural and remote areas.

According to participants, students have a lack of interest and low work ethic. Cole (1998) proposes a reason for this by stating that students are not motivated to taking challenging courses and are intimidated by science. The result is that not enough students are entering into science careers. In order to address the concerns of participants, Cole (1998) recommends that the science program should match the work of scientists and be presented in terms of its practical application in the business and service industries. Perhaps then students would be more interested and more motivated to learn science, complete their homework, and take challenging courses.

A final theme that was evident in both participant responses and the literature was inadequate science resources. Jenkins (2003) claims that labs are not challenging, equipment is out of date and inadequate and Edna reiterated these points stating there is a “lack of money for equipment” and “outdated equipment.” Hodson (2008) would like to see more open-ended project work to make the real world although recognizes that school science budgets make this impossible. Sam’s comments reveal the same truth regarding science budgets. He stated “The resource budget should be sufficient to cover program needs” implying that it is not.

Three themes that emerged from participant responses to question three that were not evident in the literature review were time constraints, teacher workload and stress, and teacher training, each of which are not specific to science education. Although a

number of participants stated that they do not have enough time to set up labs or prepare for the amount of material to cover, lack of time is an issue that all teachers face, not just science teacher. The researcher believes that the literature on science education would not reveal lack of time as an issue in the delivery of science education since this is an issue for all disciplines. Similarly, teachers from all subject areas experience increased workload and stress. Participants commented on specific stresses in the science program regarding lab safety, but classroom management, class size, course load, and expectations from employers are not specific to science teachers. Finally, pre-service teacher training and professional development are types of teacher training that are common to all areas in education. Such topics would therefore not show up specifically in literature on science education.

What are the roles of principals, science department heads and lead teachers in the delivery of science education?

All participant responses were read together and coded as one unit rather than separating principals' responses from those of science department heads and lead teachers. Once the five themes were determined, the researcher separated the responses of each group in order to compare them with the literature on the role of the principal and the role of the science department head.

According to NSTA (2003) both principals and department heads are responsible for arranging meeting to improve teaching and learning, promoting collaboration, providing mentoring for new teachers and promoting the use of data to inform instruction. Principals should also involve others in the decision making process and provide support for assessments whereas department heads have the additional responsibility of encouraging a variety of teaching styles within their department. Each

of these duties reflect the role of an instructional leader which was the most predominant theme in participant responses. Both principals and science department heads felt their role was to provide instructional leadership, ensure curriculum outcomes are met and provide a quality science education is delivered to students.

Domenech (2002) feels that the main job of principals is being instructional leaders. Again the theme of instructional leadership is evident in the literature and in participant responses. Ian, a principal, believes his role is to “oversee instruction,” to “work with the science Department Head and science teachers regarding instructional issues/challenges.” Adam, a teaching principal in a rural school stated that it is his duty to try to provide the best education for his students.

The Schools Act (1997) outlines the duties of principals in Newfoundland and Labrador. As instructional leaders they must ensure instruction matches curriculum, ensure evaluation procedures are acceptable, evaluate programs, promote cooperation and place students in appropriate courses and programs. Another theme that emerged from responses and is evident in the literature is that of accountability. Principals are accountable to ensure teachers are performing their jobs. Sam, a principal stated: “My job is to ensure that the curriculum outcomes are met.”

One theme that was dominated by administrative responses was support teachers. Four principals and one vice-principal in the study responded that they feel their role is to support science teachers through the provision of resources, the development of the school schedule, and by offering professional development opportunities. Perhaps Ian’s is the most encompassing. He stated:

I am the principal so ultimately I have full responsibility for programming, scheduling, budgeting etc. ... Additionally, if there is a need in the science department, I advocate on their behalf to the District and/or Dept. of Ed. I also look for PD opportunities for my science teachers and encourage them to go. This also involves some financial support for them.

Quinn (2002) agrees that principals should provide ongoing professional development for teachers and Goldsmith and Pasquale (2002) add that principals should learn more about the resources needed to improve science education.

A final theme that emerged from principals' responses was the role of advocate. Some principals believe that it is their role to advocate for science, although this is not present in the literature. Rather, principals must represent the needs of all departments, not only that of science. It is the role of the science department head then to advocate for the needs of the science department. Jill stated: "As a department head, I see my role as an advocate for science education in our school and to provide the district/department on the challenges and successes we experience in our school."

There is a gap in the literature on the role of the science department head. Research is abundant on the role of teachers in the classroom, yet it is lacking regarding how department heads affect the delivery of programs. Zepeda and Kruskamp (2007) found that the role of department chairs was not well defined, instructional supervision was intuitive rather than taught and there a lack of time and emphasis devoted to their role.

Department heads in this study defined their roles and four themes emerged: instructional leader, focus on the learner, accountability and advocate for science. The absence of department head responses linking to the theme of supporting teachers is likely due to the fact that all department heads in Newfoundland and Labrador are they themselves classroom teachers. Instead their responses detailed their role as a science teacher rather than their role as a department head:

- “to spark interest in science and to help students develop skills” (Mary);
- make the “curriculum as interesting and meaningful as possible to the students” (Juanita); and
- “to instill in my students a love of science and learning” (Julie).

Avalon East School District (2002) produced a document detailing the roles of department heads including coordinating the delivery of programs, providing professional development and advising the administration. Indeed, department heads in this study perceive that their role is that of an instructional leader and that they are accountable in the delivery of programs. Dan feels it is his duty to oversee curriculum and instruction in the classroom and John added that it is his duty to ensure curriculum outcomes are being met and core labs are being performed. Department heads did not, however, mention professional development which is part of the document provided by Avalon East School District, which leads the researcher to believe that the administration takes care of this area.

What are some innovative methods that are used to improve the delivery of science education and to promote scientific literacy in Newfoundland and Labrador?

The researcher chose to use the words innovative methods in this question instead of technologies because she did not want to limit the participant responses based on leading terminology. Rather the purpose of this question was to explore the methods used by educational leaders to improve science education.

The most predominant theme that emerged was the use of technologies in the science classroom. The use of computer program (such as Corel presentations and Powerpoint), online simulations, the internet, Smartboards, and online labs through CDLI were all quoted by participants as innovative ways to improve science education and

promote scientific literacy. Although many participants have such technologies available to them, other participants commented that a lack of access or lack of funding was a barrier in trying to improve science teaching and learning. Julie stated: "Personally, I would like to do more with the Internet and computers, however ... the computer room is not up to par and that a period in the computer room is too frustrating for both me and my students." Throughout other questions participants stated that they did not have adequate supplies for delivering the science program and therefore would also not have the same access to modern technology as would another school with a bigger science budget. For example, many teachers are beginning to use Smartboards in the classroom (Ziolkowski, 2004; Starkman, 2006; Baker, 2007; and Campbell & Mechling, 2009 for example) and Greg, Eric, Ben and Ian also reported the use of Smartboards in their schools. Not all science teachers have a Smartboard in their room and must therefore be creative in their teaching based on what is available to them. Ramussen, Resler, and Rassmussen (2008) use WebQuests in response to low science budgets, but not one participant mentioned the use of WebQuests in their school.

Other innovative methods that were reported by participants can be applied to other classrooms. The themes of diverse teaching strategies and assessments and innovative projects and activities emerged from participant responses, and examples were given that pertained to science teaching, although these methods could be applied to other disciplines. Some diverse teaching strategies included focusing on the diverse needs of the classroom, creating a professional learning community, and linking the curriculum to current events. Formative assessments, assignments on current issues, self tests and pre-tests are all assessment strategies used by participants that could be applied in other classrooms. Finally, some innovative projects and activities that were reported include journal writing, innovative lab delivery and using popular media in the classroom.

The two remaining themes that emerged in response to this question were science activities outside the classroom and hands-on activities. Science fairs, field trips and science competitions have been going on for decades, although participants still believe that these activities are innovative ways to improving teaching and learning in science. Henry seemed very adamant that hands on activities are the best way to promote science: "The most innovative way is actually old school. We do science as opposed to lecture on science. The more we do the more we promote."

Although many new technologies are available, schools will have limited access to such devices based on funding. Teachers need to be creative, use what they have at their disposal, and network with their peers to learn about new ways to improve teaching and learning in science education.

How can the delivery of science education be improved to better meet the changing needs of our workforce?

Although it has been recognized in the literature that science education is an important factor in determining the strength of the economy, researchers have failed to delineate how we can improve science education to meet the needs of the job market. Hodson (2008) states that improving science education will improve a country's economy and ensure competitiveness in the global marketplace yet he does not specify what changes need to be made. Some suggest that the goal of universal scientific literacy is the answer, yet researchers cannot agree on what this entails (Hodson, 2008).

Four themes emerged from participant responses to this question: changes to curriculum, focus on the learner, provide training for teachers, and link the classroom with the workforce. Participant responses called for a focus "on skills and understanding" and "More doing" in preparation for pursuing a science career. They

want teachers to receive more training and professional development to keep up to date on current teaching methods and technologies. The most predominant theme was that of curriculum, participants feel that the curriculum content should be cut down so that teachers can spend more time on ensuring student understanding. They also suggested that material be made more relevant to students, to allow students to apply their knowledge to practical applications. This is consistent with what is stated in the literature. According to Coles (1998) employers feel that practical application is more important than content.

There is a gap in the literature regarding the benefit of scientific literacy for jobs both inside and outside the science fields. Participants recognized that science is important for a variety of career options and called for the curriculum to “link science with the skilled trades” and show that “there are many other areas where an understanding of science is valued.” Some participants suggested a cross-curricular approach. Although participants had several suggestions, the literature on science education does not specify how to change the delivery of science education to meet the demands of the changing workforce.

5.3 Summary

This chapter presented the findings of the study as guided by the research questions. Summaries of participant responses were given along with salient quotations where necessary. Where relevant, the literature on science education was cited and discussed with respect to its relevance to the findings of this study. Comments made by the researcher were included within the summaries.

CHAPTER 6

Conclusions and Implications

6.1 Introduction

This chapter is divided into two sections. The first section discusses the conclusions reached by the researcher as a result of the findings presented in Chapter 5. The second section suggests a number of implications arising from the study which are listed and discussed with reference to both practice and research.

6.2 Conclusions

Based on the findings of this study, several conclusions are stated below regarding educational leaders' perspectives on science education in Newfoundland and Labrador.

1. Educational leaders view science education as important for the development of students and for the future of society.

By taking science courses student will develop important critical thinking and decision making skills that they will use throughout their lives. Technological advances have relied on scientific discovery and understanding. By developing science skills students will be better equip to both understand and develop modern technology. They will also be better prepared for the demands of higher education and the workforce as a result of the preparation received in science courses. Not only will individuals benefit, but society in general benefits from having a scientifically literate population. Science education has been the major driving force behind many of the inventions that have improved our quality of life. It also has the potential to provide the answers to many of the issues that face humankind today (depleting water supplies, global warming, ensuring sustainability).

2. Educational leaders view scientific literacy as their goal in the classroom.

The reasons why participants view science education as important were synonymous with the definitions provided for scientific literacy. That is, participants view scientific literacy as the goal of science education – to provide knowledge and understanding, to teach science skills and processes, to help students read, understand and communicate scientific issues, and to connect science with real world experiences. This is significant given that the aim of science education in Newfoundland and Labrador, as defined by the Department of Education, is to develop scientific literacy. In addition Bybee (1997) states that scientific literacy can be used as a metaphor for “the goals and purposes of science education” (p. 71).

3. The major issues facing science education are not subject dependent, they affect all teachers regardless of their discipline.

The major issues facing science education reported by educational leaders included:

- an overloaded curriculum that is too broad and contains insufficient local links;
- not enough time to address specific curriculum outcomes due to a number of extenuating circumstances;
- large class sizes, extracurricular duties and classroom management cause increased workload and stress;
- insufficient professional development and training for teachers; and
- apathetic students with a diverse set of needs.

As is evident from the list, these issues are faced by all educators regardless of the subject being taught. Rather than seeking solutions to such problems by focusing on individual disciplines, educational leaders need to take a systems approach and treat these issues as universal. Only then will solutions be implemented globally and prove to be effective.

4. Educational leaders in rural Newfoundland and Labrador face unique challenges and have different needs as compared with those leaders in other areas of the province.

Teacher student ratios are determined based on student population which means that schools with smaller populations do not have enough teachers to deliver a full course load, let alone offer a variety of courses from which student can select. In addition, the distribution of funding is also determined by student numbers meaning that smaller schools have considerably smaller budgets to work with and cannot offer the same modern technologies as larger schools. Other challenges that are unique to educational leaders in rural Newfoundland and Labrador include monitoring the delivery of distance education, teaching extra courses, retaining trained teachers, and teaching in a multi-age setting. Perhaps the participant that best depicts the challenges of teaching in a rural setting is Adam, a principal in rural Newfoundland who teaches 18 courses and oversees technology for his school.

5. There are similarities and differences between the roles of principals and the roles of science department heads in the delivery of science education.

Both principals and department heads perceive that their role includes being an instructional leader, being accountable in ensuring curriculum outcomes are met, and advocating for science. However, there were also differences in the roles of principals and department heads as reported by participants. Responses from department heads revealed that they must also focus on the needs of the learner by keeping their interest, delivering an enriched science curriculum and preparing them for the future. The researcher feels that principals did not include the needs of the learner in their responses since principals are not directly involved in the classroom. Principals stated that supporting teachers by providing resources, planning the school schedule, and searching for professional development is part of their role in the delivery of science education.

Supporting teachers was not evident in the responses of department heads. The researcher feels that this theme did not emerge from their responses since department heads themselves are classroom teachers and have little influence on such topics as the distribution of resources, scheduling and professional development opportunities.

6. Science skills and knowledge, curriculum, technology, the needs of the learner, and teacher training are persistent themes that categorize the perceptions of educational leaders in Newfoundland and Labrador.

Participants emphasised the importance of having a science education that teaches the appropriate skills and knowledge needed for real world applications. They provided constructive criticism regarding the present curriculum and technologies available for educators. Educational leaders also believe that by focusing classroom practice on the needs of the learner and by providing training and professional development for teachers we can improve the delivery of science education and work towards a scientifically literate population.

6.3 Implications

The findings and conclusions from this study present several implications that are relevant to practice and research.

6.3.1 Implications for Practice

This study examined the perspectives of educational leaders on the delivery of science education in Newfoundland and Labrador. It provided participants with the opportunity to reflect and crystallize their thinking with respect to the issues they face in providing the best science education possible. Several suggestions were made by participants as a result of taking part in this study, suggestions that would have not otherwise been published. *It is therefore recommended that educational leaders discuss issues in science education with their academic staff and work towards improving the*

delivery of science education. This could be done at regular department meetings or during professional development days. By discussing the issues particular to each schools, educational leaders can develop a plan to address these issues and potentially include this plan school improvement initiatives.

The culture and climate of each school varies and therefore the needs of each school varies. This is particularly true for rural schools. With smaller school populations and reduced staffing, rural schools face different challenges as compared with larger schools in the delivery of science education. Although a formula exists to determine the resources available to each school, this formula should not be strictly applied to rural schools. In order for science education to be delivered in an equitable fashion, rural schools need to be consulted so that their unique needs are addressed. *It is therefore recommended that the Department of Education initiate a process of review and evaluation of the delivery of science programs in rural Newfoundland and Labrador in order to determine the specific needs of rural schools and to develop ways and means to address those needs.*

Science teachers have many roles in the delivery of science education that deal with specific classroom practices. Educational leaders should have a different set of roles by nature of their position and the power they have to influence change. In this study, science department heads responded to many questions in terms of their role as a classroom teacher. There is little information available on the specific roles of science department heads and principals in the delivery of science education in our province. *It is recommended that the Department of Education, by working with educational leaders, better delineate the roles of principals and science department heads in the delivery of science education.*

6.3.2 Implications for Research

The general population agrees that a solid science education is important in securing employment, yet the employment needs of each region depends on a variety of factors, for example geography, culture, religion, or climate. In addition, there is little research available to delineate what aspects of science education are important for the workforce, that is what skills need to be taught in order to prepare students for a variety of jobs both inside and outside the field of science. *It is therefore recommended that the Government of Newfoundland and Labrador conduct a study to determine the impact that science education has on the workforce.* The economy of a province is largely determined by whether or not young people can secure meaningful employment. If our government wants to provide a sustainable economy they need to provide funding for research and development to determine the skills that employers seek.

On an even larger scale, improving science education can improve a nation's economy and increase competitiveness in the global marketplace. Participants in this study agreed that science education influences society. Although they did not specifically mention globalization, they did recognize that science education has an impact on the world. Again, the impact is not fully explained in the literature. How does a country improve science education to meet the needs of globalization? *It is therefore recommended that the Government of Canada conduct a study to determine the impact that science education has on globalization.* The CMEC is already in place to and is working to ascertain a quality, equitable and effective delivery of education to all Canadian citizens. By shifting the focus on the demands of globalization the CMEC can determine how the delivery of science education needs to change and adapt.

6.4 Concluding Comments

This study offers a variety of benefits to the following groups or individuals: the schools, teachers, department heads and administrators; the four school boards, the Department of Education; and the researcher. All of the participants in this study were asked to reflect on and communicate their perspectives regarding science education in Newfoundland and Labrador, which would not have happened in the regular, hectic schools day. Such an exercise is valuable because it forces participants to reflect on their classroom practices, their role in the delivery of science education and the needs that they have. By giving participants the opportunity to participate in this study, they are given a voice – the opportunity to make their perceptions known and give suggestions as to how the delivery of science education could be improved. The four school districts and science educators across the province will benefit from learning about methods used to improve the delivery of science education. Correspondingly should educators alter/vary their approaches to instruction in a positive manner as a result of the findings of this study, students would be the obvious beneficiaries of such changes.

Another beneficiary of this study is the Department of Education. This study can be viewed in terms of an independent evaluation of the perspectives of science educators in order to examine the current issues facing science educators in Newfoundland and Labrador, the methods used to increase scientific literacy, whether or not these educational leaders feel that science education is important for preparing students for the future. Individuals involved with curriculum development can use the suggestions given to guide future programs and initiatives.

The researcher is also a beneficiary in this process. A number of benefits accrue to the researcher:

- the development and fine-tuning of a multitude of skills related to conducting qualitative research;
- the acquisition of considerable insight into the perspectives of educational leaders on the delivery of science education,
- the development of an extensive network of educational leaders from across the province,
- the acquisition of innovative methods to use in the science classroom, and
- the intrinsic satisfaction from knowing that the exercise was an exceptional learning experience.

It is the researcher's hope that educators and stakeholders from across the province will use the findings of this study to help improve the delivery of science education and better delineate the link between science education and employment.

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APPENDIX A

Questionnaire

EDUCATIONAL LEADERS' PERSPECTIVES OF HIGH SCHOOL SCIENCE EDUCATION IN NEWFOUNDLAND AND LABRADOR

**A study to be conducted by Amanda Walsh
E-MAIL: amandawalsh@esdnl.ca**

Invitation To Participate

Introduction

Greetings principals, science department heads and science educators of Newfoundland and Labrador. You are invited to participate in a study examining the current issues facing science educators in our province.

Data Collection

Data will be collected electronically. Your participation will consist of responding to the items on a questionnaire (see Appendix A). Your participation is voluntary and anonymous.

The survey will take approximately 30 minutes to complete; you may use extra pages if necessary.

Voluntary Participation

Participation in this study is completely voluntary and you may withdraw at any time. You are also free to not respond to any particular survey item. The proposal for this research has been approved by the Interdisciplinary Committee on Ethics in Human Research (ICEHR) at Memorial University. If you have ethical concerns about the research (such as the way you have been treated or your rights as a participant), you may contact the Chairperson of the ICEHR at icehr@mun.ca or by telephone at 738-8368. The results of the research will be made available to the university community in a web-site upon completion of the study.

Thank you in advance for participating in this study.

EDUCATIONAL LEADERS' PERSPECTIVES OF HIGH SCHOOL SCIENCE EDUCATION IN NEWFOUNDLAND AND LABRADOR

SURVEY

PAGE 1

SECTION A: DEMOGRAPHIC INFORMATION

Please complete the following:

1. Please check off which region of the province you are presently working in:
 - a) Nova Central _____
 - b) Eastern _____
 - c) Labrador _____
 - d) Western _____

(NOTE: If you work with several districts, please check all that apply.)

2. I am currently working as a(an)
 - a) replacement (term) classroom teacher _____
 - b) permanent classroom teacher _____
 - c) department head _____
 - d) assistant/vice principal _____
 - e) principal _____
 - f) other (please specify) _____

3. The student enrolment of my school is in the following range:
 - a) 025 – 200 _____
 - b) 201 – 400 _____
 - c) 401 – 600 _____
 - d) 601 – 800 _____
 - e) 801 – 1000 _____
 - f) 1001 – 1200 _____
 - g) 1200 + _____

4. I am:
 - a) female _____
 - b) male _____

[Please do not mark in this space: *Survey Number* _____.]

*PAGE 2**SECTION B: PLEASE RESPOND TO THE FOLLOWING:*

1. How do you view science education? That is, how important is science education in your opinion? Please give reasons for your response.

2. What does scientific literacy mean to you?

PAGE 3

3. What are the major issues facing science educators in Newfoundland and Labrador? Please list practical examples that you might recall.

4. What is your perceived/defined role in the delivery of science education?

PAGE 4

5. What are some innovative methods that you have used to improve the delivery of science education and promote scientific literacy? Please elaborate.

6. List some suggestions as to how the delivery of science education could be improved to better meet the changing needs of our workforce.

PAGE 5

7. Are there any additional comments/points you would like to make regarding science education in Newfoundland and Labrador?

Please use the extra page(s) if necessary.
Thank you for taking the time to complete this survey.

APPENDIX B

Consent Form

CONSENT FORM

TITLE

Educational Leaders' Perspectives of High School Science Education in Newfoundland and Labrador

RESEARCHER

Amanda Walsh, Faculty of Education

You are invited to take part in a research project entitled "Educational Leaders' Perspectives of High School Science Education in Newfoundland and Labrador."

THIS FORM IS PART OF THE PROCESS OF INFORMED CONSENT. IT SHOULD GIVE YOU THE BASIC IDEA OF WHAT THE RESEARCH IS ABOUT AND WHAT YOUR PARTICIPATION WILL INVOLVE. IF YOU WOULD LIKE MORE DETAIL ABOUT SOMETHING MENTIONED HERE, OR INFORMATION NOT INCLUDED HERE, YOU SHOULD FEEL FREE TO ASK. PLEASE TAKE THE TIME TO READ THIS CAREFULLY AND TO UNDERSTAND ANY OTHER INFORMATION GIVEN TO YOU BY THE RESEARCHER.

It is entirely up to you to decide whether to take part in this research. If you choose not to take part in the research or if you decide to withdraw from the research once it has started, there will be no negative consequences for you, now or in the future.

INTRODUCTION

In this fast paced age of technological advances, many employers view an increased knowledge in the area of science as an asset. Globalization is connecting many areas of the world and individuals who have a strong science background can make these connections effective and efficient. It is important, therefore, for high schools to keep abreast of scientific innovations and to prepare students for our ever-changing world.

PURPOSE OF THE STUDY

This study will survey principals and science department heads in Newfoundland and Labrador about the current issues facing science educators in our province and the methods used to increase scientific literacy.

WHAT YOU WILL DO IN THIS STUDY

To participate in this study you will be asked to complete a survey consisting of two parts. Section A which will ask you for various demographic information and Section B will consist of approximately 7 open-ended questions.

LENGTH OF TIME

You will receive a survey via email that will take approximately 20-30 minutes to complete. Once completed you can then email or fax your responses back to me.

RISKS AND BENEFITS

The purpose of this study is to survey principals and Science department heads in Newfoundland and Labrador to determine what are the current issues facing science educators in our province and the methods used to increase scientific literacy. The researcher perceives no harms accruing from this research.

With respect to the benefits of this study, the researcher proffers the following as potential benefits accruing to you and other study participants as well as future educators in our province:

- You are given a voice and will have the opportunity to make known your perceptions of the major issues in science education in our province. Also, you will be asked for suggestions as to how the delivery of science education could be improved to better meet the needs of the changing workforce.
- Science educators across the province will benefit from learning about methods you use to improve the delivery of science education.
- Should educators alter/vary their approaches to instruction in a positive manner, students would be the obvious benefactors of such changes; and
- Individuals involved with curriculum development can use the suggestions you give to guide future programs and initiatives.

PRIVACY & CONFIDENTIALITY

You will not be asked to identify yourself on the actual survey instrument. When you submit your survey responses, these responses will be downloaded to an external (flash) drive. After the analysis has been completed, the flash drive will be stored in a locked file cabinet in my university office.

It should be noted that in the final write-up of the study, pseudonyms will be used. The above measures/procedures will ensure that the information received will be kept confidential and anonymous.

REPORTING OF RESULTS

Information collected will be used for a Master of Education thesis. Data will be reported using direct quotes, summary statements and trends that arise.

QUESTIONS

You are welcome to ask questions at any time during your participation in this research. If you would like more information about this study, please contact:

Amanda Walsh
Researcher
(709) 782-7602
amandawalsh@esdnl.ca

Dr. Jerome Delaney
Faculty of Education
Research Supervisor
(709) 737-2071
jdelaney@mun.ca

The proposal for this research has been approved by the Interdisciplinary Committee on Ethics in Human Research at Memorial University. If you have ethical concerns about the research (such as the way you have been treated or your rights as a participant), you may contact the Chairperson of the ICEHR at icehr@mun.ca or by telephone at 737-8368.

CONSENT

YOUR NAME TYPED BELOW ON THIS FORM MEANS THAT:

- You have read the information about the research.
- You have been able to ask questions about this study.
- You are satisfied with the answers to all of your questions.
- You understand what the study is about and what you will be doing.
- You understand that you are free to withdraw from the study at any time, without having to give a reason, and that doing so will not affect you now or in the future.
- You agree to participate in the study.

If you type your name at the end of this form, you do not give up your legal rights, and do not release the researchers from their professional responsibilities.

The researcher will give you a copy of this form for your records.

YOUR SIGNATURE

"I have read and understood the description provided; I have had an opportunity to ask questions and my questions have been answered. I consent to participate in the research project, understanding that I may withdraw my consent at any time. A copy of this Consent Form has been given to me for my records."

Name of participant

Date

RESEARCHER'S SIGNATURE

"I have explained this study to the best of my ability. I invited questions and gave answers. I believe that the participant fully understands what is involved in being in the study, any potential risks of the study and that he or she has freely chosen to be in the study."

Signature of investigator

Date

Telephone number: (709) 782-7602

E-mail address: amandawalsh@esdnl.ca

